FEBRUARY 1942

FEB 12 1942

The WELDING Journal

The Journal of the American Welding Society

MAILED FIST!

The welders of America are using vast quantities of Arcos Stainless Electrodes to produce dependable war equipment. You can be sure—it's Arcos.

ARCOS CORPORATION
401 N. Broad St., Phila., Pa.

it's ARCOS for stainless electrodes

"QUALITY WELD METAL EASILY DEPOSITED"

Distributors Warehouse Stocks in the Following Cities:

ATLANTA, GA.	*J. M. Tull Metal & Supply Co.*
BUFFALO, N. Y.	*Root, Neal & Co.*
BORGER, TEXAS	*Hart Industrial Supply Co.*
BOSTON, MASS. (Belmont)	*H. Boker & Co., Inc.; W. E. Fluke*
CHICAGO, ILL.	*Machinery & Welder Corp.*
CINCINNATI, OHIC	*Williams & Co., Inc.*
CLEVELAND, OHIO	*Williams & Co., Inc.*
COLUMBUS, OHIO	*Williams & Co., Inc.*
DETROIT, MICHIGAN	*C. E. Phillips & Co., Inc.*
ERIE, PENNA.	*Boyd Welding Co.*
FT. WAYNE, IND.	*Wayne Welding Supply Co., Inc.*
HONOLULU, HAWAII	*Hawaiian Gas Products, Ltd.*
HOUSTON, TEXAS	*Champion Rivet Co. of Texas*
KANSAS CITY, MO.	*Welders Supply & Repair Co.*
KINGSPORT, TENN.	*Slip-Not Belting Corp.*
LOS ANGELES, CALIF.	*Ducommun Metals & Supply Co.*
MILWAUKEE, WIS.	*Machinery & Welder Corp.*
MOLINE, ILL.	*Machinery & Welder Corp.*
NEW YORK, N. Y.	*H. Boker & Co., Inc.*
OKLAHOMA CITY, OKLA.	*Hart Industrial Supply Co.*
PAMPA, TEXAS	*Hart Industrial Supply Co.*
PITTSBURGH, PA.	*Williams & Co., Inc.*
PORTLAND, OREGON	*Industrial Specialties Co.*
ROCHESTER, N. Y.	*Welding Supply Co.*
SAN FRANCISCO, CALIF.	*Ducommun Metals & Supply Co.*
SEATTLE, WASH.	*H. A. Cheever Co.*
ST. LOUIS, MO.	*Machinery & Welder Corp.*
SYRACUSE, N. Y.	*Welding Supply Co.*
TOLEDO, OHIO	*Williams & Co., Inc.*

The Journal of
The American Welding Society
VOLUME 21 • NUMBER 2 • FEBRUARY, 1942

Billet Cutting for Steel Forgings*

By H. E. Rockefeller†

Introduction

BILLET cutting is one of the oldest applications of oxyacetylene cutting. The simplicity, the high severing rate and the accuracy of oxyacetylene cutting contributed to its early acceptance. Some of the first cutting machines manufactured, and capable only of imparting straight-line motion to the cutting blowpipe, were used on this operation.

During the first World War oxyacetylene nicking and mechanical breaking were specified in this country for shell-forging blanks in order that inspection of the fracture for defects could be made on each individual blank. Modifications in this specification have recently been issued by the Ordnance Department as a result of requests from several manufacturers who prefer to through-cut the billets in order to assure more readily the square ends required on blanks for finished-bore shell forgings. These modified specifications, which permit either complete severing to shell-blank length of billets up to 25 ft. in length with end-etch tests or alternate severing and breaking without etch tests, have given considerable impetus to oxyacetylene cutting in the manufacture of munitions.

Recent developments in oxyacetylene cut-off machines specifically designed for the cutting of round and square bars, both at room and elevated temperatures, have not only materially improved the efficiency and increased the scope of oxyacetylene cutting, but have made possible production rates much higher than hitherto obtainable. In the following discussion, current practices, which include recent developments for both oxyacetylene cutting and nicking of shell blanks at room temperature, will be described together with the hot-cutting of shell ingots, and hot- and cold-cutting of billets to length for shipment to the forging manufacturer.

Bridge-Type Cut-Off Machine

While it is representative of the oldest type of machine used for cutting, the portable straight-line Monitor-type of cutting machine, operated from a track support bridging over a row of billets bedded side by side, offers a practical and economical set-up, particularly for small billets and double-lengthened blanks employed in the upsetter-type forging process. A recent installation employing this cutting arrangement both for rounds and squares is illustrated in Fig. 1.

The bars are lined up on beds long enough to accommodate two lengths and 40 to 50 widths. A gantry carriage, on which the track and a tractor-type cutting machine are mounted, spans the bed and can be moved lengthwise over its entire length. The track carriage is located in the approximate location for making a cut and locked at the side rails. Exact positioning of the cutting blowpipe is accomplished by means of the adjustable cross slide provided on the cutting machine.

By using a welding blowpipe to heat the starting point of the bar ahead of the one being cut, the cutting opera-

Fig. 1—Shell-Forging Blanks Are Being Cut from Round Bars by Means of a Portable, Straight-Line Monitor-Type Cutting Machine Operated from a Track Support

* Paper presented at the Annual Meeting, A. W. S., Philadelphia, Pa., Oct. 20 to 24, 1941.

† Manager, Process Development, The Linde Air Products Company, New York, N. Y.

tion is made continuous across an entire row of bars. After completing a cut across the row of bars, the gantry is moved along the bed to the next cut-off position and the operation repeated.

In the method employed at this plant, all bars in a single batch are cut to shell-blank length without movement of the bars. While cutting is going on at one end of the bed, the cut blanks are removed from the other end, and another set of bars is placed in position for cutting, thus permitting the cutting operator to work practically without interruption. Both rounds and squares are cut in this manner.

With one cutting operator, assisted by two helpers who clear the beds, load the cut blanks and reload the beds, a production of 100 to 110 blanks per hour is easily maintained from shift to shift on $3^1/_{16}$-in. squares. Cutting speed on this size is 9 to $9^1/_2$ in. per minute with consumption of approximately 2 cu. ft. of oxygen and 0.4 cu. ft. of acetylene per blank. On $2^3/_8$-in. rounds a cutting speed of 11 to 12 in. per minute is maintained with resultant production of between 130 and 140 blanks per hour.

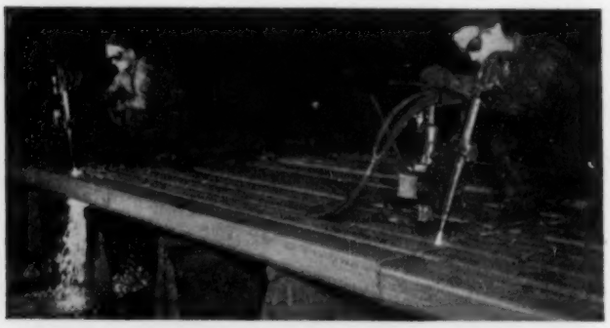


Fig. 2—This Portable Machine Is Being Widely Used in Steel Mills for Squaring the Ends of Rolled Bars, Removing Etched Test-Specimens, Cutting Bars to Length for Shipment from the Mill and for Dividing Bars Into Lengths Required for Individual Forgings

Several other plants are using a set-up quite similar to the one shown, except that the bars are placed on conveyor tables against a stop at one end, while the track, which bridges the cutting bed, remains stationary. Following completion of a cut, the stop is removed, and the cut blanks dropped to a loading platform. The uncut lengths of the bars are then pushed against the stop for a repetition of the operation.

Portable Hydraulic Link-Type Bar-Cutting Machine

Recognition of certain limitations to the adaptation of existing general-purpose cutting machines for billet cutting indicated the need a few years ago of a cutting machine specifically designed for this operation. This resulted in the development of a portable-type machine capable of cutting cold bar stock of either round or square sections in sizes ranging from 2 to 15 in. Machines of this type, such as illustrated in Fig. 2, are being used in various mills to square the ends of rolled bars to remove etch-test specimens, to cut bars to length for, shipment from the mill and to divide bars into lengths required for individual forgings. This machine requires neither electric power nor track on which to operate. It employs a self-contained spring-driven power unit, the spring pressure producing a torque on the shafts to which the linkage mechanism is attached. The cutting speed is hydraulically controlled, providing ideally

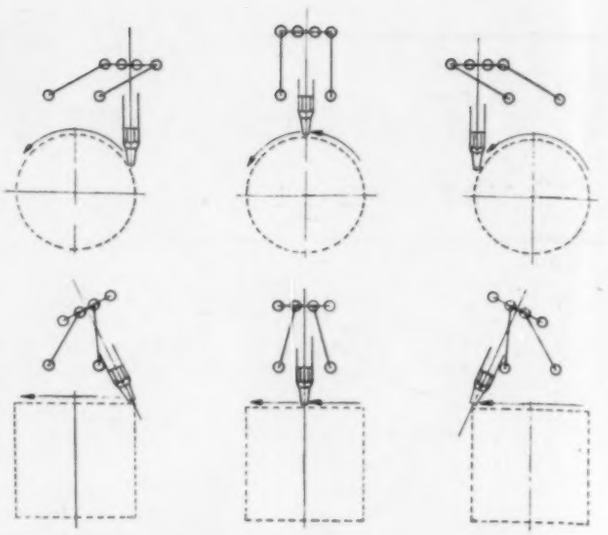


Fig. 3—The Mechanism Controlling the Movement of the Cutting Blowpipe Is Designed to Permit the Blowpipe to Follow Closely the Contour of the Section Being Cut, Whether It Be Square or Round

smooth and infinitely variable blowpipe motion. Simple adjustment of the linkage provides for a semicircular motion of the cutting blowpipe when cutting rounds, and a swinging motion which gives the maximum efficiency in cutting squares. These motions are illustrated in Fig. 3. When the mechanism is adjusted so that the effective length of the supporting arms is equal and parallel, the blowpipe nozzle will follow a semicircular path, with the radius of the arc depending upon the arm length. When the machine is adjusted with the arms of equal length but converging at the pivoted crossbar on which the blowpipe holder is mounted, squares may be cut. With this linkage setting, the blowpipe moves through a small arc, but the blowpipe pivot is automatically raised and lowered so as to maintain a constant height between the nozzle and the work.

The weight of the machine, complete with blowpipe, is less than 53 lb. Little time is lost in moving and setting up the machine between cuts as it is readily portable, and the machine base is so designed that it can be quickly and accurately positioned on the bar with little

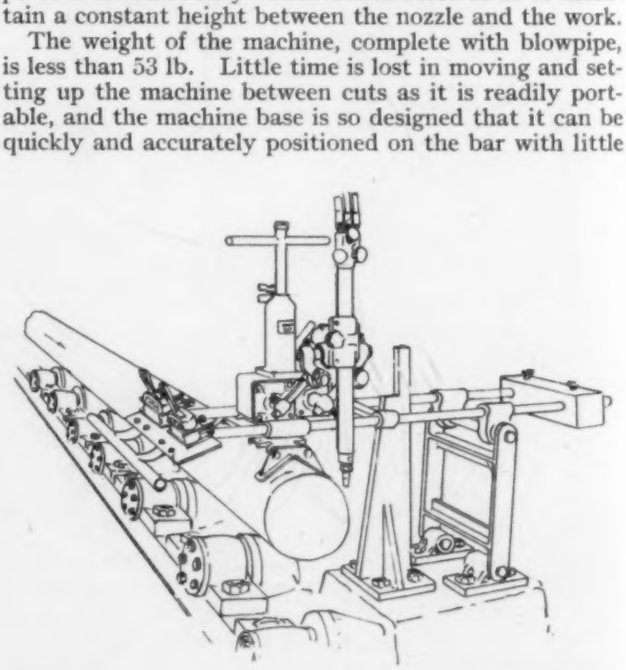
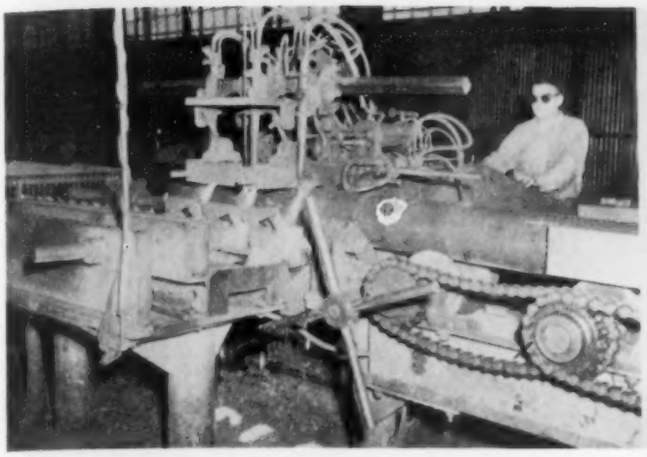


Fig. 4—This Machine, of Similar Design to That Previously Described, Has Been Adapted for Stationary Operation in the Cutting of Shell Forging Blanks



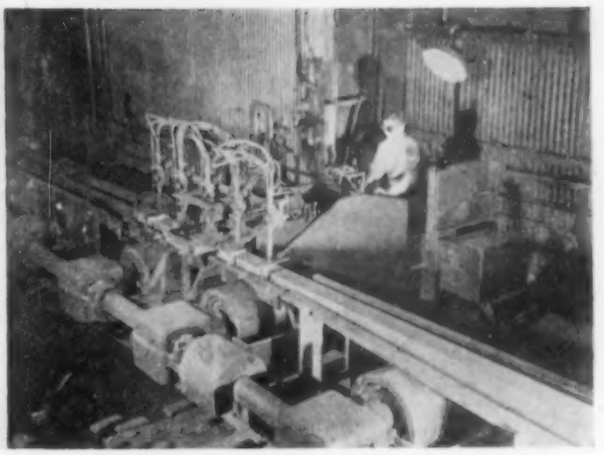


Fig. 5—A New Stationary Type Multi-Blowpipe, Automatic Bar-Cutting Machine Has Been Recently Introduced to Meet the Increased Demand for Large-Scale Production of Shell Blanks
Fig. 6—This Machine, Equipped with Special Nozzles Which Do Not Cut Completely Through the Bar, Is Used to Nick Shell Forging Blanks

effort. A high production rate can be obtained with this type of machine, one operator recently having made 790 cuts on $3^1/_2$ in. Gothic squares in a single 8-hr. turn.

For cutting shell blanks, this type of machine has been adapted for stationary operation by mounting it on a counterweighted arm similar to that shown in Fig. 4. With this arrangement a roller conveyor is employed to move the bars to and away from the machine. By the use of the double-linkage arm shown in the illustration, the cutting machine can be centered on either round or square stock even though the piece being cut is considerably off the center line of the conveyor. Remote valving is provided for controlling the preheat and cutting gases.

Multi-Blowpipe Automatic Bar-Cutting Machine

To meet the increased demand for large-scale production of shell blanks, a stationary-type multi-blowpipe, automatic bar-cutting machine is being developed. The machine combines the unique features of the portable unit and, in addition, provides for multi-blowpipe cutting, supplementary preheat for quick starting and completely automatic operation. Much higher production rates can be developed than with other types of machines previously described.

A general view of this machine is shown in Fig. 5. This machine is designed for installation on a permanent foundation adjacent to a roller conveyor table which moves the sections to be cut up to the machine, and then carries away the cut blanks on the opposite side. It will be noted that the blowpipes are supported by a crossarm which in turn is attached to a linkage system. This linkage system provides the cutting blowpipes with the same swinging motion for cutting squares and semicircular motion for cutting rounds as are featured in the portable, hydraulically operated machine previously described.

While only three blowpipes are mounted on the arm as shown, as many as five blowpipes are being used with this machine, the number employed being determined by the amount of camber in the bars and by the lengths of the blanks to be cut. The distance between blowpipes and their location in relation to the machine frame and the stock being cut can be readily adjusted by quick-acting clamps which fasten the blowpipe holders to the crossarm.

Table 1—Production Data for Cutting Cold Round and Square Bars (3-Blowpipe Operation)

Bar Size, In.	Preheating Time, Sec.	Cutting Time, Sec.	Handling Time, Sec.	Total Time, Sec.	Production Rate, Pieces per Hr.	Probable Production, Pieces per Hr.
			Round Bars			
2	3	10	10	23	470	400
3	5	15	12	32	336	280
4	7	20	15	42	255	220
6	9	38	20	67	159	135
8	12	63	30	105	102	85
10	15	98	45	158	66	55
			Square Bars			
2	2	12	10	24	450	380
3	4	17	12	33	327	270
4	6	23	15	44	243	200
6	8	41	20	69	156	130
8	10	69	30	109	99	85
10	12	107	45	164	66	55

Supplementary preheating blowpipes supply additional preheat at the starting points and appreciably reduce the time required for starting the cuts. Supple-

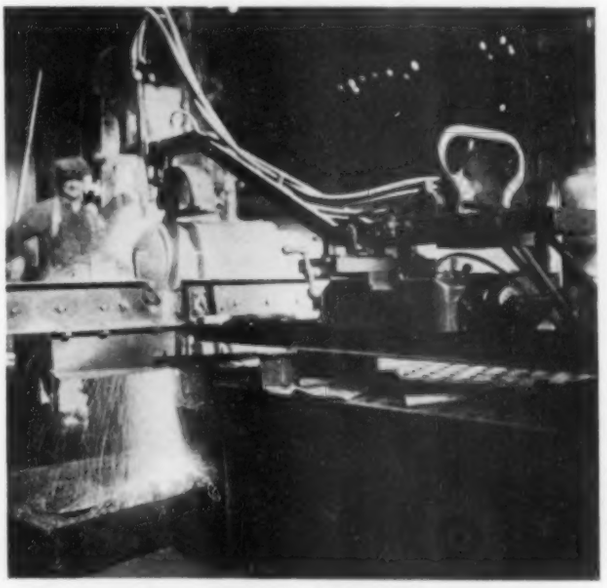
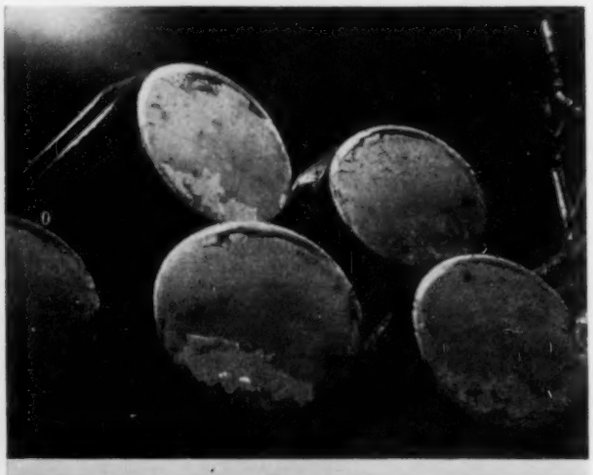


Fig. 7—Oxyacetylene Cutting Is Being Used to Remove the Domed Bottoms from Cast-Steel Forging Blanks

mentary preheating is particularly effective on rounds where the preheat flames of the cutting blowpipe impinge tangentially at the starting point. The cutting functions of the machine, including the lighting and shutting off of the preheat gases and flow of the cutting oxygen, are all controlled by one manually-operated sequence lever.

Table 1 presents an idea of the production rates obtainable on different sizes of round and square bars with this machine. These production rates, of course, are dependent upon the facilities provided by the user for conveying material to and away from the machine, but the allowance for handling time is generous where suitable conveying systems are provided. Furthermore, the data are based upon three-blowpipe operations; where five blowpipes can be employed, production rates can be increased proportionally.

Fig. 8—The Quality of the Cuts Obtained on These Cast-Steel Forging Blanks Is Indicated in This Photograph



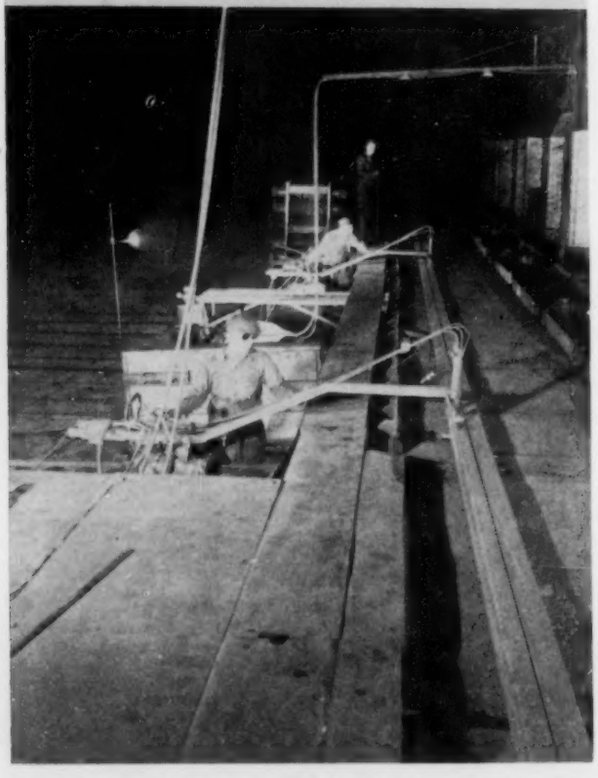


Fig. 9—Long Billets Are Here Cut to Shipping Length While They Are Still Hot by Means of Two Tractor-Type Oxyacetylene Cutting Machines Equipped with Extension Arms and Water-Cooled Cutting Blowpipe

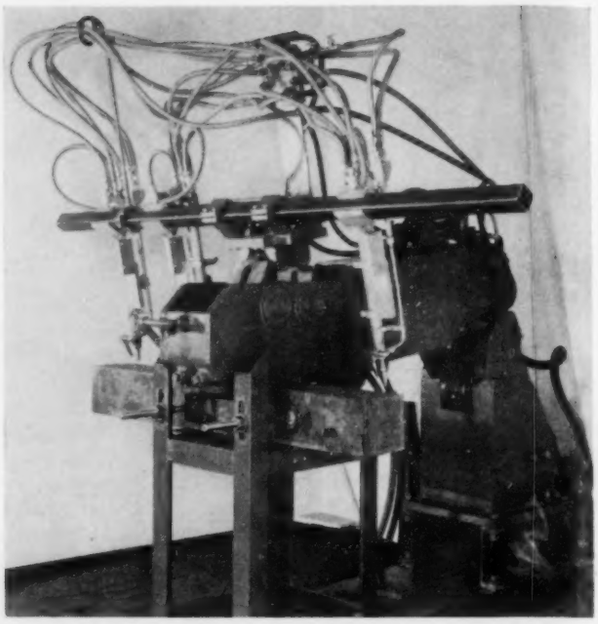


Fig. 10—This Is a Fully Automatic Hot Bar Type Machine Designed for Oxyacetylene Cutting of Bars in the Steel Mill Rolling Line in Place of Shearing or Hot Sawing

The cutting rates shown in the third column might be questioned since they are noticeably faster than those given in previously published data. These cutting speeds, however, are based upon the performance of an improved design of cutting nozzle. A considerable improvement in cutting efficiency as well as cutting speed is obtained through the use of a special divergent shape of the cutting oxygen bore. This special design produces higher cutting jet velocities without a corresponding detrimental increase in exit pressure.

Oxyacetylene Nicking of Billets for Shell Blanks

Although the trend seems to be away from the nick-and-break method of producing shell blanks, this method is still employed in a number of plants, the practices of which were established before the recent liberalization of the Ordnance specification. One manufacturer is effectively employing the last described type of machine for this operation. A general view of the machine with five blowpipes mounted on the crossarm is shown in Fig. 6. The 5-in. by 5-in. round-cornered squares are being nicked at $15^1/_8$-in. intervals. A narrow $^1/_4$-in. deep groove is produced with a special bent cutting nozzle. The actual cutting time is only 15 sec. with an oxygen consumption of less than $^1/_2$ cu. ft. per nick. A production rate of 350 nicks per hour is easily maintained. After the cutting, the nicks are quenched in order to assist in the subsequent breaking operation.

The same type of machine is also being employed to make alternate nicks and cuts simultaneously. In this operation the nick is made on the near side of the billet instead of on the top. Both the cutting and nicking blowpipes are started as if two complete cuts were to be made, but when the nicking cut has reached the desired depth, the cutting oxygen and preheats are shut off on the nicking blowpipe, thus terminating its cutting action. In the forging operation, the accurately squared cut

Fig. 11—This Shows a Cross-Section View of Oxyacetylene Cut Through a Steel Billet Containing Four Longitudinally Drilled Holes Filled from Left to Right with Rod of Stainless Steel, Medium Carbon Steel, Cast Iron and Bronze

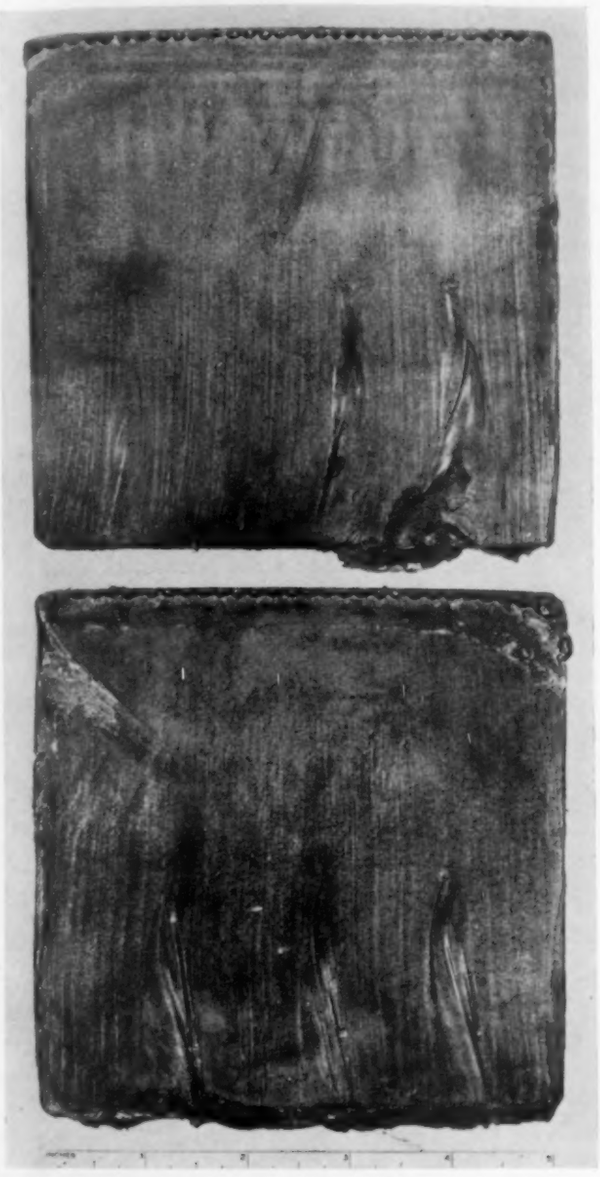


Fig. 12—This Cut Surface Is from a Section of Steel Billet Prepared with Drill Holes Filled with Medium Carbon Steel Rods Which Were Ground with a Flat on One Side

surface is placed face up in the forging press to aid in maintaining the piercing tool on center.

Hot-Cutting of Forging Ingots and Billets

Operations heretofore described, all have applied to cutting at room temperature or so-called cold-cutting. Cutting at elevated temperatures has also been applied at the steel mill both for cutting of billets to shipping lengths and for cutting of forging slugs for immediate processing. Hot-cutting is also being employed in the sizing of individual shell-blank ingots.

In one Canadian plant blanks for 9.2-inch shell forgings are cast into 12-in. square ingots with domed bottoms and sinkhead tops. Mechanical cutting at elevated temperatures is employed to remove the bottom and top, and to provide a forging blank of the required length and squareness. The ingots, after being stripped at about 1700° F., are placed lengthwise on a conveyor table and moved to the first cut-off position where the domed bottom is removed. This operation is illustrated in Fig. 7. This unit consists of a tractor-type machine on which is mounted an overhanging arm pivoted on the machine carriage. A roller at the extreme end of this arm rides on a templet and, as the cutting machine moves forward, imparts the required semicircular motion to the blowpipe nozzle and maintains its proper elevation above the work. The quality of the cuts obtained is illustrated in Fig. 8. These cuts are made in 1 min., 28 sec. with an oxygen consumption of approximately 23 cu. ft.

Following the bottom cut-off operation, the ingot is conveyed to the second cutting position where the sinkhead is removed. The second cutting unit is essentially the same as that previously described. In this operation, however, the roller, instead of riding on a templet, comes directly in contact with the ingot surface. A short movable section of the conveyor operated by an air cylinder tilts the ingot approximately 30° to facilitate starting the cut. The cutting of the square end sinkhead requires 35 cu. ft. of oxygen and the cutting operation is accomplished in 2 min., 30 sec.

The cutting of these shell ingots, which are approximately 0.5 per cent carbon, at elevated temperatures offers two advantages over cold-cutting. The cutting efficiency is greater than that at room temperature. The temperature gradient of cooling on the cut surface is reduced and any possibility of cracking of the cut surface during handling is therefore eliminated.

Another application of hot-cutting which a number of mills have adopted for the cutting of shell billets to shipping lengths is illustrated in Fig. 9. In this operation hot billets are transferred from the billet mill to a run-out table where cutting machines located at the desired lengths from a stop sever the billets to shipping lengths. Each unit consists of a water-cooled blowpipe supported by a counterweighted extension arm pivoted on the carriage of a portable straight-line cutting machine. A roller attachment is mounted on the end of the arm and rides on the billets, thus maintaining a uniform height between the nozzle and the work. A number of

Table 2—Hot Bar Cutting Machine Data

Time Required for Making Mild Steel Bar Cut-Offs at Different Steel Temperatures

Square Bar Size, In.	Seconds Required per Cut 70° F.	1400° F.	1600° F.	1800° F.	2000° F.
2	10	4	3	3	3
4	23	12	10	9½	8
6	41	25	21	20	17
8	69	45	39	37	34
10	107	75	68	67	61
12	175	118	103	103	99
14	280	168	140	140	123

Round Bar Size, In. Diam.	Seconds Required per Cut 70° F.	1400° F.	1600° F.	1800° F.	2000° F.
2	8	3	3	2½	2½
4	20	10	8	8	7
6	38	23	19	18	16
8	63	41	36	34	31
10	98	70	65	62	56

* This table does not include preheat time required before starting cuts.

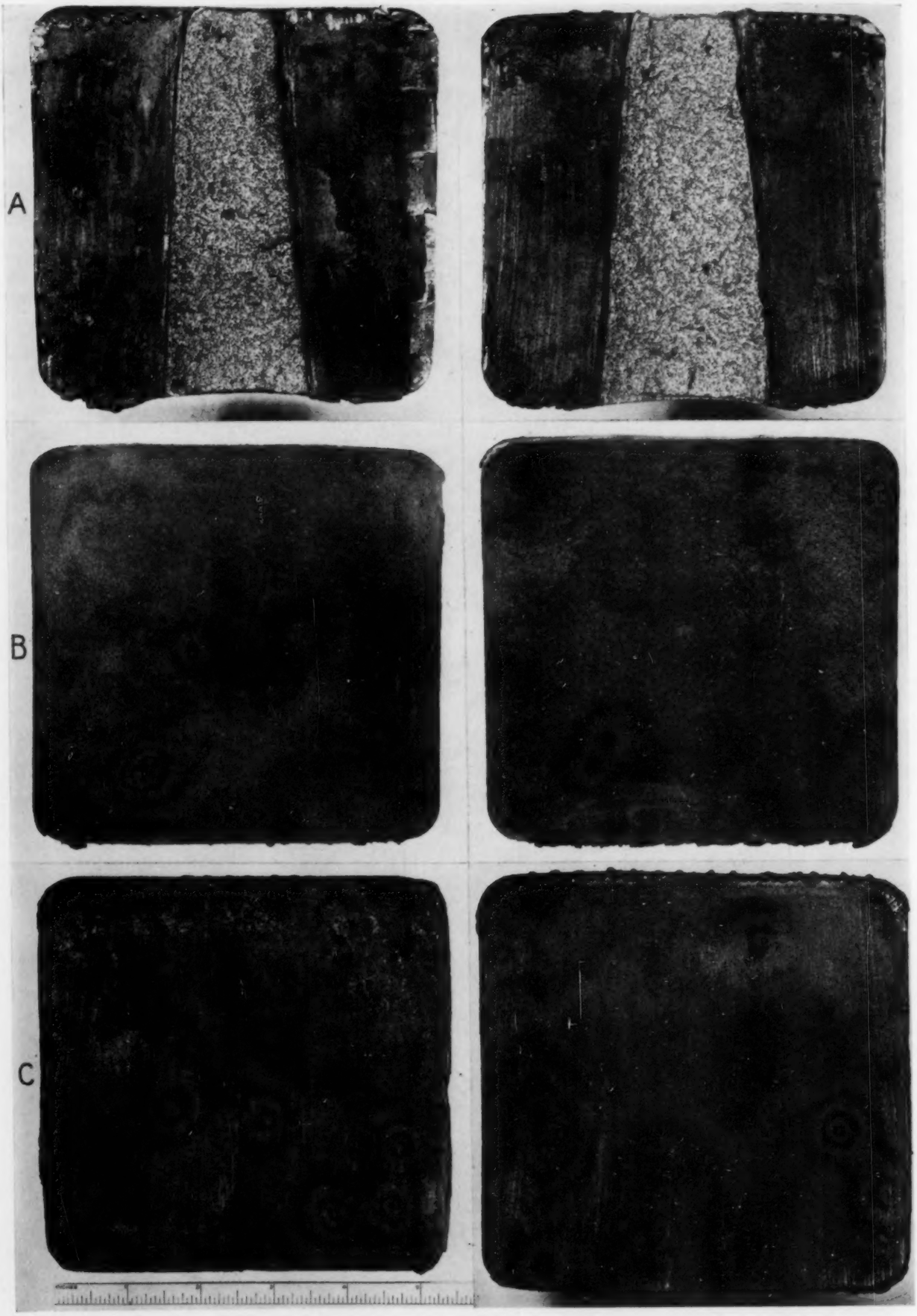


Fig. 13 (A, B, C) (Left)—This Shows Nick-Break, Etch-Test and Flame-Cut Surfaces in a 5-In. Billet at a Point Where a Defect of Appreciable Magnitude Was Encountered

Fig. 14 (A, B, C) (Right)—This Shows the Comparative Nick-Break, Etch-Test and Flame-Cut Surfaces Through a Section Closely Preceding the Termination of the Defect

other units which are similar but which incorporate a swinging motion to the blowpipe for obtaining maximum cutting speed and minimum oxygen consumption have also been installed.

The interest which has been expressed in the possibilities of oxyacetylene cutting of bars in the steel-mill rolling line in place of shearing or hot-sawing has resulted in the development of a fully automatic hot-bar type of cutting machine similar in many respects to one of the machines previously described. A general view of this machine with three water-cooled blowpipes mounted on it is shown in Fig. 10. The boom of this machine is water-cooled and protects the operating mechanism from the heat radiated by the billets when cutting is done at rolling temperatures. The machine is hydraulically operated and remotely controlled. The control table can be installed at any convenient location away from the heat. Several cutting units can be operated from a single control panel. This feature is particularly important in cutting long lengths at a high production rate where separate cutting units are required.

The machine illustrated is now being installed at an Eastern mill for cutting relatively short slugs used in a special process for manufacture of seamless tubing. By cutting the slugs hot, not only is the cutting cost reduced, but the reheating cost is minimized.

Higher speeds and lower oxygen consumptions are obtained by cutting at elevated temperatures. The time for making cuts in round and square bars at different temperatures is shown in Table 2. The oxygen consumption compared to cutting at room temperature is about inversely proportional to the cutting time. In cutting steel at rolling temperature, furthermore, flying starts can be made. This eliminates the necessity of accurately lining up a series of blowpipes at the individual starting points on the billets.

Detection of Pipe in Oxyacetylene Cuts

Anyone experienced in either manual or mechanical cutting of heavy sections and particularly steel castings is acquainted with the fact that defects encountered in the plane of an oxyacetylene cut will result in an audible sputtering in the cutting reaction which usually results in a gouge being made on the cut surface originating at the point of the defect. In the cutting of steel risers nozzle design and cutting procedure have been such as to minimize the gouging effect produced when defects are encountered in order that defects of appreciable size can be bridged over without losing the cut.

When oxyacetylene cutting was introduced in place of nick-breaking for the production of shell blanks it was assumed that the oxyacetylene cut would not be subject to inspection for defects as is done with a fractured surface. Ordnance specifications, therefore, to date have required either an alternate nick-break and cut or samples for etch-test examination at each end of the bars. In view of the known cutting reaction which develops where defects of appreciable magnitude are encountered in the cutting of cast steel, it has been felt that a cutting procedure could be established which would show up defects on the cut surface of rolled bars at least to the extent that they are shown up in a fractured surface.

The results of an investigation recently made on this premise definitely indicate that, with proper cutting procedure, secondary pipe or inclusions in billets will be shown up on the cut surface by a gouge emanating from the defect. Because of the difficulty of securing billets with known defects therein, the original tests were carried out on sound material by drilling longitudinal holes through the billet and filling these with materials having varying rates of oxidation. A typical section filled from left to right with rods of stainless steel, medium-carbon steel, cast iron and bronze is shown in Fig. 11. Gouging below the inserts of cast iron and bronze is very noticeable. With the stainless steel insert, a distinctly noticeable gouge developed on the specimen, but does not show clearly in the photograph. No appreciable disturbance was caused in cutting through the medium-carbon steel insert.

Inasmuch as the pipe in billets generally terminates in a thin crack or fissure, cuts were also made on material prepared with drilled holes filled with medium-carbon steel rods which were ground with a flat on one side. The fissure between the rod and side of the hole was 0.015 in. thick and 0.1 in. wide, and the rods were inserted so that the location of the fissure varied in each instance. The cut surface from a section of material prepared in this manner is shown in Fig. 12. The gouges below the inserts are equally noticeable, regardless of whether the fissures were located on top, side or bottom.

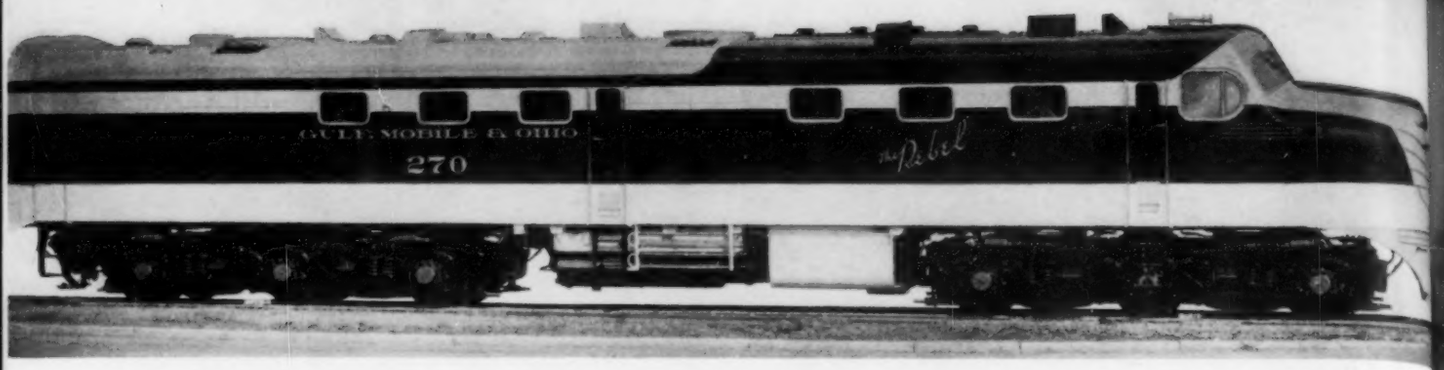
These results having been established on sections simulating pipe in billets, a number of samples of billets containing actual defects were tested to check the procedure. In carrying out these experiments, nick-break tests and etch tests were made within $^1/_2$ in. of the cut surface in each instance to permit a comparative examination being made of the three surfaces. Nick-break, etch-test and flame-cut surfaces in a 5-in. billet at a point where a defect of appreciable magnitude was encountered, are illustrated in Fig. 13. Further tests were made on a section wherein the defect terminated within the length of a given bar, and a comparative record was therefore established which traced the defect to its termination. Comparative nick-break, etch-test and flame-cut surfaces through a section closely preceding termination of the defect are illustrated in Fig. 14.

It is the writer's opinion that these tests leave little question as to the practicability of examining flame-cut surfaces for defects which are of sufficient magnitude to cause rejection of the cut blank as unsuitable for forging.

In view of these results, it appears as if oxyacetylene cutting not only affords a means of economically securing accurately sized and square shell blanks but provides a means for surface inspection of the ends.

Summary

In this discussion several different types of installations for both cutting and nicking of billets have been described. In view of the recently developed multi-blowpipe, automatic machine for cutting short lengths such as for single-length shell slugs, it is believed that the trend will be away from nicking and breaking to complete severing by the oxyacetylene process. This seems almost assured if recognition is given to the inspection of oxyacetylene cut surfaces as a means of inspection of the blanks for defects. For most forge shops where demands do not call for large numbers of forging slugs of a single size and length, the portable type of machine which can be readily taken to the work will, it is believed, provide the most economical and practical means for the cold-cutting of bars to forging blank length. For large-scale production, the multi-blowpipe, automatic machine appears to offer a practical solution. Hot-cutting at the mill will undoubtedly continue to be used increasingly as the possibilities of this application are more fully appreciated and developed.



2000 B. H. P. Diesel Locomotive Built Sept. 1940

Welding as Applied to Locomotives*

By James Partington†

ELECTRIC arc welding, gas welding and forge welding were in use to a considerable extent in the construction of new locomotives and the repair of locomotives that were in service in the early part of the 1910 decade.

On new work butt welds in locomotive fireboxes were made first with oxyacetylene and later by electric arc welding, using bare wire. In applying patches in locomotive fireboxes the same methods were used.

All of these welds were in the stay-bolted areas of the firebox and gave satisfactory results—the welds being supported by other means.

In some railroad shops repairs were made to the shell portion of locomotive boilers by electric arc welding, the welds being made from the outside only.

These welds were not stress-relieved and would not meet the test requirements of present-day codes, nor the procedure rules of the AMERICAN WELDING SOCIETY. They were generally unsatisfactory—new cracks soon developed when the locomotives were put back into service.

These conditions caused the Bureau of Locomotive inspection of the Interstate Commerce Commission to issue orders prohibiting all welding on the pressure parts of locomotive boilers and permitting only the welding in the fireboxes as above outlined with the provision that no firebox welds be allowed higher than 14 in. below the top of the crown sheet. Due to the improved methods which were gradually developed by following the welding rules, promulgated jointly by the AMERICAN WELDING SOCIETY and the Boiler Code Committee of the American Society of Mechanical Engineers, including the use of covered electrodes in place of bare welding wire, completely welded fireboxes are now permitted.

These completely welded fireboxes are now in general use and are giving satisfactory service.

By special permission of the Bureau of Locomotive Inspection of the Interstate Commerce Commission, one completely welded boiler was built by the American Locomotive Company. This boiler was built in accordance with the rules of the A. S. M. E. Boiler Code for Power Boilers and the design and construction procedure were approved by the Mechanical Division of the A. A. R. This boiler has been in successful operation on the Delaware and Hudson Railroad for the past four years.

No additional completely welded boilers for locomotives have yet been permitted although two railroads at the present time wish to put welded boilers in service.

Other important items of fusion welding now in general use for locomotive boilers are: welding of stay-bolt sleeves and caps, welding of the firebox door hole seam, welding of washout plug sleeves and welding of smoke-boxes.

Important items of fusion welding on other locomotive parts are: welding of cabs and Diesel locomotive hoods, welding of ash pans, welding of locomotive tender tanks, welding of the sheathing of streamlined locomotives, welding of Diesel locomotive underframes and welding of electric locomotives.

Fusion welding in railroad shops has been greatly improved in quality in recent years. Many railroad shops are following closely the AMERICAN WELDING SOCIETY procedure for process and for qualifying their welders. Two striking examples of welded construction fabricated in railroad shops are: welded cylinders and welded hinge connection for articulated locomotives.

The application of fusion welding to locomotive parts is not restricted by the I. C. C. and welding is extensively used on new work and in making repairs. The use of welded parts on new locomotives has advantages as follows: neater appearance, saving in weight and reduction in development costs by the elimination of patterns. The advantages of welding in making repairs are similar to those realized in other industries.

The outstanding prospect of the further extension of welding as applied to locomotives will be realized when the I. C. C. permits the general use of *welded* boilers.

Welded Firebox

The welded firebox is completely fabricated, before it is placed in the boiler shell.

The alignment and over-all dimensions of welded fireboxes are held to a plus or minus tolerance of $\frac{1}{8}$ in. This close workmanship permits the drilling of all stay-bolt holes in the flat sheets, i.e., before the sheets are flanged or rolled.

All of these joints are double welded butt joints. The welds are hand welds made in a down position with D.C. 28–30 volts, and approximately 150 to 170 amperes. None of these welds are stress relieved.

---

* Presented at the Annual Meeting, A. W. S., Philadelphia, Pa., Oct. 20 to 24, 1941.

† American Locomotive Co., New York, N. Y.

Welding of Stay-Bolt Sleeves and Caps

It is desirable that these sleeves or caps be welded in place accurately in alignment and that the minimum amount of bobbing or repairs be required to insure tightness under pressure.

It is generally agreed that the best results are obtained by the use of covered or coated electrodes.

Before the welding operation is begun, it is extremely important that all scale be removed from the surface of the boiler plate and that any oil which may have been deposited in stay-bolt holes during machining operations must be removed.

Our Company is using 20-volt D.C. with about 165 amperes, $^{5}/_{32}$-in. wire and, as far as possible, the welding is performed in a down-hand position. These welds are not stress relieved.

Welding of the Firebox Door Hole Seam

This type of weld has been in use on locomotive boilers for many years. It replaced the old practice of attaching the firebox door sheet flange and the backhead flange by a lap seam with a single row of patch bolts instead of rivets because only one side of this seam is accessible. For this same reason the weld for the welded type of seam can be made from one side only. This weld is not stress relieved.

Welding of Smokeboxes

On present-day new locomotives the smokebox of the locomotive boiler has gradually changed from a straight cylindrical course to a rather intricate shape, some times partly conical, some times flattened on the under side and, in many cases, with indented sections. The use of welding has enabled the builder to fabricate these smokeboxes with less labor, has provided a cheaper assembly and a smokebox of much neater appearance than can be produced by riveted construction. None of these welds are stress relieved.

Welding of Cabs

These parts are welded primarily to get a neater outside appearance. The welded construction also gives some weight saving and greater flexibility from a designing and fabrication standpoint.

Welding of the Sheathing of Streamlined Locomotives

The use of welding instead of riveting has made possible the streamlining of locomotives. A smooth finish cannot be satisfactorily obtained in any other manner. If the joints in the light sheathing plates had to be made by riveted construction, even if butt joints with an inside welt strip and countersunk rivets were used, the job would be much more expensive and less desirable. For this type of work, which requires a smooth outside finish, welded construction is the only feasible method.

The designs of streamlining which have been developed up to this time are numerous, differing in a greater or lesser degree on all railroads that have adopted streamlining. The type of welding used must be adapted to the varying conditions with special attention being given to performing the work in a way that will prevent distortion.

Welded Tender Tanks

A large proportion of these tanks for new locomotives are now of welded construction which provides a very smooth and pleasing outside appearance because rivet heads are eliminated.

Many welded tanks have been built with practically no change other than the substitution of welding for riveting. This does not contribute any material saving in weight, nor saving in cost.

To get maximum advantage from the change to welded construction, the design of the tank should be adapted to this type of construction. For example, the swash plates can be attached direct to the sides of the tank with intermittent fillet welds, thus eliminating the vertical tee bracing necessary for attaching the swash plates when riveting is employed.

By spacing these swash plates at sufficiently close intervals, no other bracing of the side sheets is necessary unless it is deemed advisable to have longitudinal bracing to assist in preventing warping, and to provide rigidity during fabrication.

All of the angles required for attaching the top tank plate in riveted construction can be eliminated and this top plate can be welded in place from the outside by the use of fillet welds and plug welds at the swash plates.

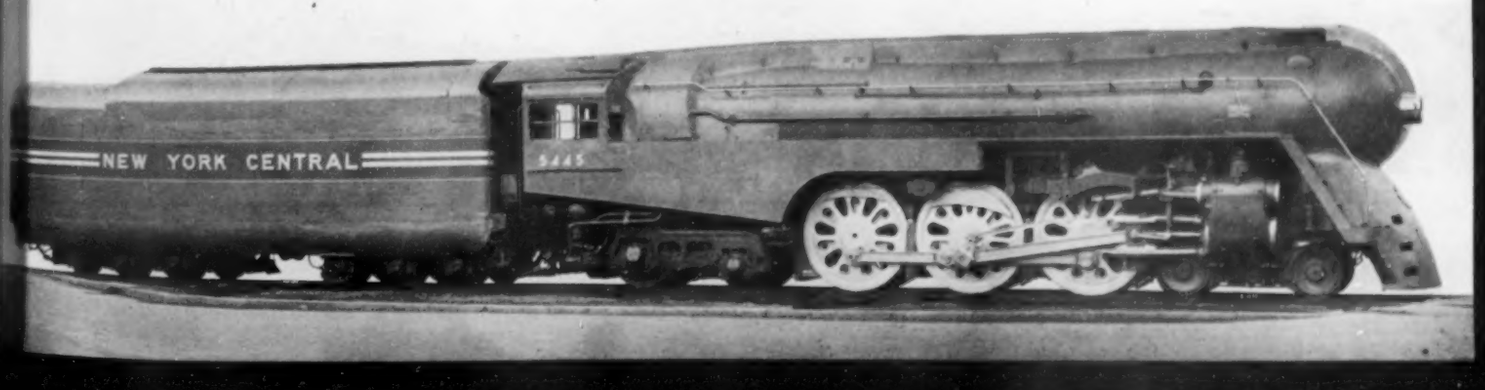
A tank fabricated in this way will have very considerable weight saving and the major portion of the welding can be performed in a down position. The top plate being applied last, the necessity of welders working in an enclosed area is avoided.

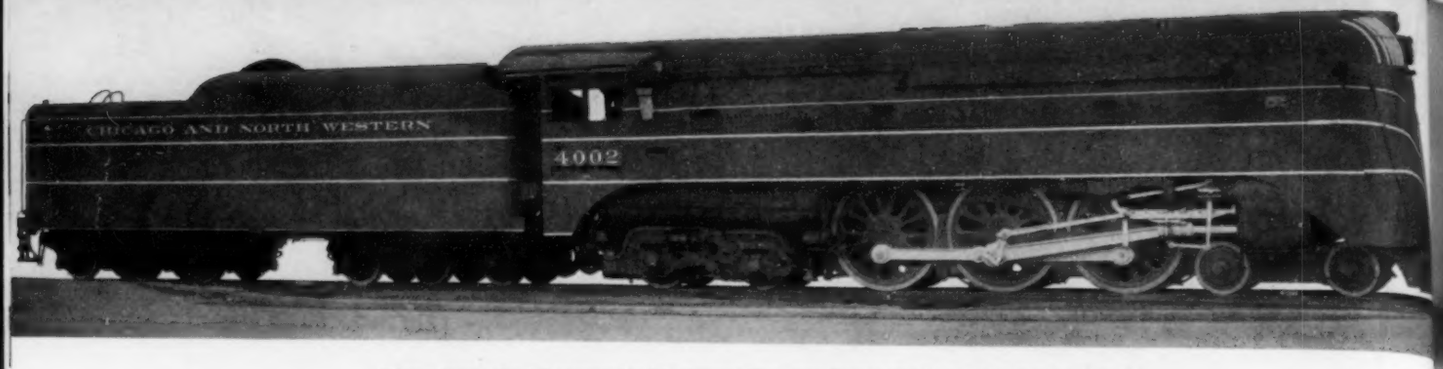
Welded Tender Frames

A limited number of tender frames fabricated of structural shapes by welding have been constructed and put in service on the railroads.

The welded connections have been almost entirely fillet welds but with several beads of welding being deposited because the web thickness of the parts is from $^{1}/_{2}$ to 1 in. All of these tender frames have been put in service without stress relieving and have given satisfactory service. These tender frames, if properly designed, will show a substantial weight saving over the integral cast steel tender frames in general use.

Soft Coal Locomotive Built March 1938 Maximum Tractive Power Engine 43,440 Lb. Booster 12,100 Lb.





Bituminous Coal Locomotive Maximum Tractive Power 55,000 Lb. Built March 1938

Locomotives—Other Than Steam

The types of welding required on the mechanical portion of electric locomotives and Diesel electric correspond, in general, with the types used on steam locomotives and tenders.

The best example of electric locomotive welding is the all-welded electric streamliner recently built by the General Electric Company for the Paulista Railway of Brazil.

This locomotive design is outstanding in several respects:

(*a*) It is the largest locomotive to be fabricated entirely by welding—cab, underframe and trucks.

(*b*) It is the first streamlined electric locomotive to be built in this country for export.

(*c*) The main platform is one of the most massive structures for a motive power unit yet to be fabricated entirely by welding.

(*d*) The main truck frames are, up to the present time, the largest locomotive truck assemblies entirely of welded construction.

The cab underframe of this locomotive is one of the largest single structures yet assembled by welding fabrication in a locomotive shop.

The backbone of this structure, which is 72 ft. long, consists of two 142-lb., $21^1/_2$ x $13^1/_8$-in. H-beams, running the full length of the structure and forming the main center sills.

These beams are located about 5 ft. apart and are reinforced with top and bottom plates $^1/_2$ in. thick, forming the floor of the cab as well as a central duct which is used for distributing air from the blowers to the traction motors.

The side sills of this structure are 10-in. standard steel channels welded to each side of the main structure, bringing the total width to a little more than 10 ft.

Bolsters supporting the center plates, side bearings and lifting lugs are built of heavy H-beams and plates.

In fabricating the main H-beams, the width of the beams has been reduced where less rigidity is required, thus reducing the weight of the structure. This reduction has been effected by cutting away the flange on both sides of the web to give a tapered form without changing the height of the web and by flame cutting several openings in the web.

The total weight of this platform structure when ready for assembling the cab is somewhat in excess of 50,000 lb.

The driving trucks and the guiding trucks of this locomotive were both fabricated by flame cutting and welding.

The side frames of the driving trucks are constructed from rolled, normalized open-hearth steel slabs 4 in. thick and the side frames for the guiding trucks are fabricated from steel plate $1^1/_2$ in. thick.

In the fabrication of this extremely long cab a new welding technique permitted the subassemblies of portions of the sides and roof to be welded together in jigs on the shop floor or in the case of the rounded ends formed over cast-iron blocks and the seams completely welded.

In the final assembly the various subassemblies were erected on the cab platform and welded permanently in place.

The principal advantages realized by this welded construction were:

1. The problem of streamlining for speed and appearance was simplified.
2. A distinct saving in weight and material was secured without loss of strength or rigidity.
3. The method used assisted in cost reduction without sacrificing quality or utility.

Welded Cylinders for Locomotives

For more than two years the Pennsylvania Railroad at its Altoona Shops has been replacing cast locomotive cylinders on its Class M-1 locomotives with welded construction and about thirty of these locomotives equipped

Welded Locomotive Boiler

with welded cylinders are now in service. No defects have developed.

These cylinders are an intricate assembling and welding job. There are 177 separate pieces involving 1200 linear feet of welding and the use of 2150 lb. of welding electrodes. All of this welding is done by qualified welders.

Jigs and positioning fixtures are used extensively so that more than 90% of the welding is performed in a down-hand position.

Flange quality steel is used throughout and after welding the completed assembly is stress relieved at 1050° F. which is held for five hours.

Appreciable saving in weight is effected by this change. These cast steel cylinders before machining weigh 18,300 lb., while the welded assembly before machining weighs 13,350 lb.

Welded Hinge Connection and Frame Crosstie

Welded construction has been substituted for a steel casting.

The design was first fabricated and used by the Union Pacific Railroad in connection with a change in design which they adopted for their 4664 simple articulated fast freight locomotives. These units are stress relieved.

The D. & H. Welded Boiler

This welded boiler has been in service on the Delaware and Hudson Railroad for four years.

It was subjected to four thorough inspections during the first year, two the second year and the usual yearly inspection since that time.

This boiler has a perfect record and it may be that more welded boilers for locomotives will soon be permitted by the Interstate Commerce Commission.

Although the use of welded pressure vessels has made tremendous strides and the use of welded boilers in stationary service is becoming almost universal, welded boilers for locomotives are not permitted.

The use of welded boilers would give the railroads relief from the many cases of intergranular cracking of boiler shell plates of locomotive boilers that have been a recurring source of trouble.

The I. C. C. has adopted within the last year a welding code for pressure tanks for tank cars, and it is hoped that welded boilers for locomotives will soon receive similar recognition.

Reducing Machinery Cost

By Robert Wagner*

OFTEN relatively simple changes in design, made possible by welding, not only reduce the cost of a piece of machinery, but also increase its efficiency. This was the case with a pump that was designed for use in the Old Ocean Oil Field, the highest pressure field in the Texas Gulf Coast area, according to Professor H. B. Rigsby, of the Agricultural and Mechanical College of Texas. The conventional duplex pumps previously employed gave a great deal of trouble because of the complicated castings used and the extremely high pressure under which they were operated. It was difficult to keep the cylinders in accurate alignment; weak points in the castings often gave way; and interchangeable parts were hard to produce.

The new design, employing welded instead of flanged joints, greatly simplified the castings, made it possible to use standard fittings and assured accurate alignment of the cylinders, with a resultant reduction in wear on packing and plungers. In addition, the machining time was greatly reduced and maximum interchangeability of parts was made possible.

The old design is shown in Fig. 1. The flanged joints were eliminated in the new welded design shown in Fig. 2. The cylinders were held in alignment during the welding operation by a heavy pipe machined to fit the cylinder bores, and positioning was done with a chain hoist. Under a hydraulic pressure of 10,000 psi, there was no failure at any point during tests, and the pump was subsequently put into operation under a pressure of 1350 psi. The cost of the pump as previously built was $6300, while the welded design cost $4600 and had a 20% greater capacity.

* Hobart Brothers Co., Troy, Ohio.

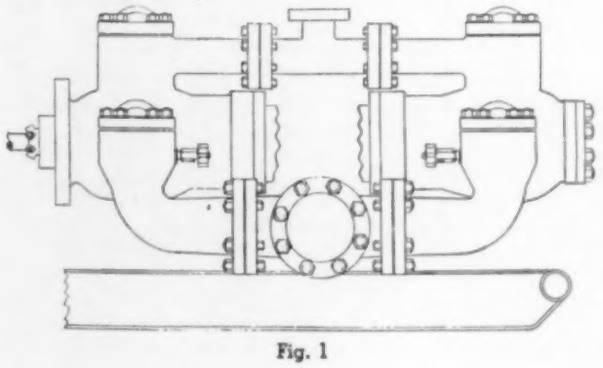


Fig. 1

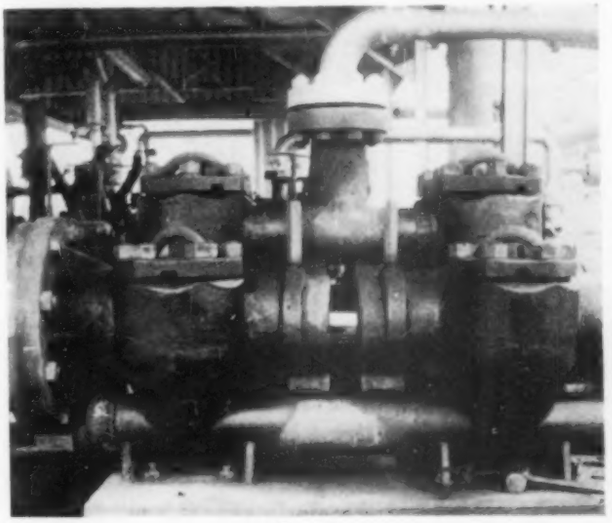


Fig. 2

The Use of X-Rays in General Industrial Application

By R. T. Foreman*

ANYTHING contributing to speed in production finds hearty endorsement from industrial leaders and from defense officials. X-ray examination is playing a big part in the defense effort and is helping the industrial machine gather momentum for the job ahead.

X-Ray in 1917

During the World War I, X-rays were used to detect flaws which might result in disastrous failure of equipment—high-pressure boilers, vital power mechanisms such as turbines, flywheels, valves, etc. At our plant in Covington, Ky., we set up X-ray equipment which was used by industries located in neighboring Cincinnati, Ohio. Thousands of vital castings and forgings were checked before finding their way into the ships which kept the sea lanes open. The Army called on us for X-ray equipment to be used at McCook Field (now Wright Field), Dayton, Ohio. Here were constructed model airplanes which were tested in wind tunnels, observers carefully checking the models with X-rays to locate points of weakness in internal wing structure and other concealed parts.

X-Ray Today

X-ray equipment in use at that time was very bulky. Exposed high-voltage lines offered a constant menace to the operator, and a great deal of "stray" X-ray energy emanated from the open tubes. Tremendous strides in design have been made in the last ten years—all high-voltage equipment is now immersed in oil in sealed containers—high voltage is carried to the tube in flexible insulated cables, encased in a metal sheath connected to the ground. X-ray tubes are immersed in oil, greatly reducing the size of their metal container and protecting the operator from high-voltage shock.

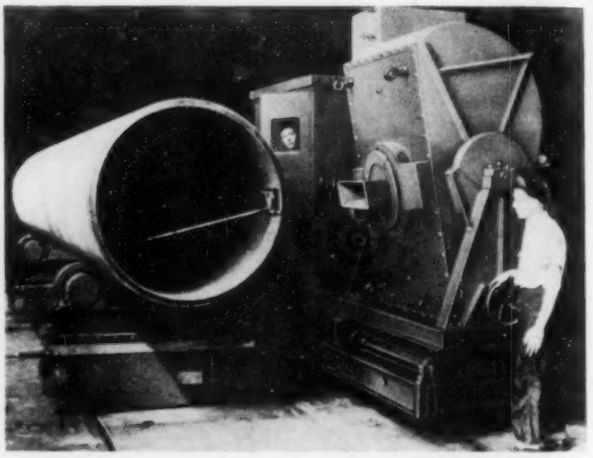


Fig. 2

Operator protection is carried still further by providing lead-lined booths for use while films are being made. The result of these precautions is that workers in X-ray departments enjoy excellent health and suffer no ill consequences if they observe the necessary simple precautions.

* The Kelley-Koett Mfg. Co., Inc., Covington, Ky.

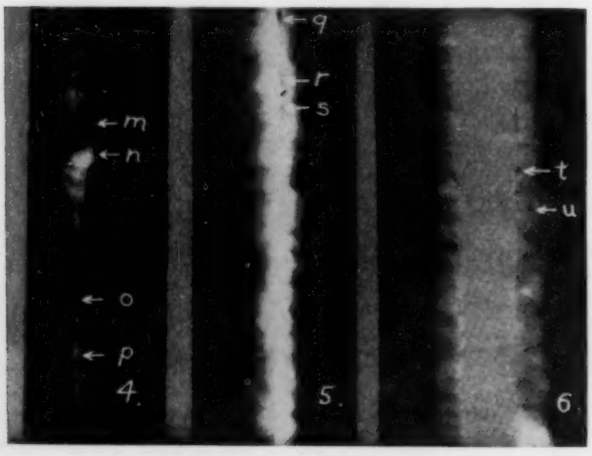


Fig. 1

Detecting Flaws

In the two decades following World War I, X-rays were increasingly used with the same thought in mind—to detect flaws and prevent failures. At Boulder Dam the huge penstock pipes, 30 ft. in diameter, were welded as each section was installed, and examined with X-rays immediately after welding. More than 270,000 ft. of X-ray films were used in this location, and it was possible to reweld suspicious joints and forestall failure at some later date when repair would be difficult or impossible.

X-Ray Testing

This application of X-rays in industry has grown enormously in the last few years, and from it has arisen a new concept of the usefulness of such examinations. Films are no longer made with the negative idea of rejecting work already done, but with the positive, constructive idea of improving manufacturing processes so that the cause of the defects will be eliminated. In dealing with castings,

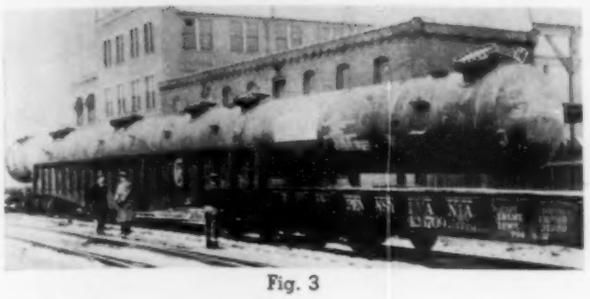


Fig. 3

for example, the manufacturer may examine pilot castings to develop satisfactory fabricating technique. Each radiographic examination is interpreted, and changes in production are then made until the pilot castings demonstrate that a satisfactory practice has been worked out. From this point, only occasional random castings are used to check production—in many industries, 90% of the films are made for production control and only 10% or less for routine examination of castings.

Welding

Application of X-ray examination of welds has resulted in great improvement in the quality of welded joints. Defects resulting from entrapped slag, porosity, incomplete fusion and cracks are clearly visible on the X-ray film. In welds, as in castings, the examination reveals the presence and nature of internal defects not discernible on the surface. As the X-ray beam passes through the material, it produces a shadow picture of the specimen. Variation in the shadow intensity indicates lack of uniformity in the material, and the cause of the non-uniformity can be deduced. Flaws amounting to as little as 2% of the total thickness—even as little as one-half of one per cent in favorable cases—can be detected.

Figure 1 shows three welds, each apparently perfect in surface appearance, yet the middle film obviously shows an area of poor fusion which may result in failure in service. If the weld had been examined by sectioning, the defect might have been missed and the welding process would have been called satisfactory. The X-ray beam showed that the process was not adequate, and a change in technique was made which produced the perfect welds shown on each side.

Boilers

Figure 2 shows a typical 400,000-volt machine in use at the Henry Vogt plant. An idea of the size of the finished boilers can be obtained from Fig. 3. The boiler requires three large flat cars for transportation and can be moved only in the daytime and over certain railroads because of the tremendous clearances required of bridges and tunnels.

In other cases, failure of a weld might result in an expensive shutdown and slow up production for national defense. A stainless steel tank containing important chemicals might develop a small leak in a weld and stop an entire plant. Repair must be made under difficult conditions at the site—an X-ray examination before installation would have prevented the failure.

Molecular Structure

Use of the diffraction method of X-ray analysis makes it possible to peer into the very composition of matter and visualize the arrangement of molecules. When a sample of the material is placed in the path of a narrow pencil of X-rays, reflection occurs from each molecule, and the film will record a circular image whose shape depends on the molecular arrangement of the material.

Figure 4 shows three diffraction patterns taken of one sample of steel. The first pattern obviously differs from the other two—the reflections indicate that the molecules are arranged in haphazard fashion and are under great strain. The steel is then partially annealed and the middle pattern is obtained—the molecules are rearranging themselves in a more symmetrical pattern. Finally, after complete annealing, the molecules produce the pattern shown at the right of Fig. 4. They are symmetrically arranged and the sharpness of each line indicates that no strain exists.

Diffraction analysis is of great importance in the steel and alloy industries, where stresses and strains are a vital factor. A slightly different method (spectral analysis) is used, in which the X-ray beam and the specimen are arranged in such manner that a series of dark bands are obtained on the film. The position of these bands shifts according to the composition of the material and the degree of strain. It is the same sort of analysis, made with X-rays, that permits astronomers to analyze the light from stars and determine their temperature, composition and speed. The uniformity of an alloy—the "solubility" of the metals with respect to each other—can be determined. Once again X-ray points the way to production of materials of complete homogeneity, free of defects which may result in disastrous failure in service.

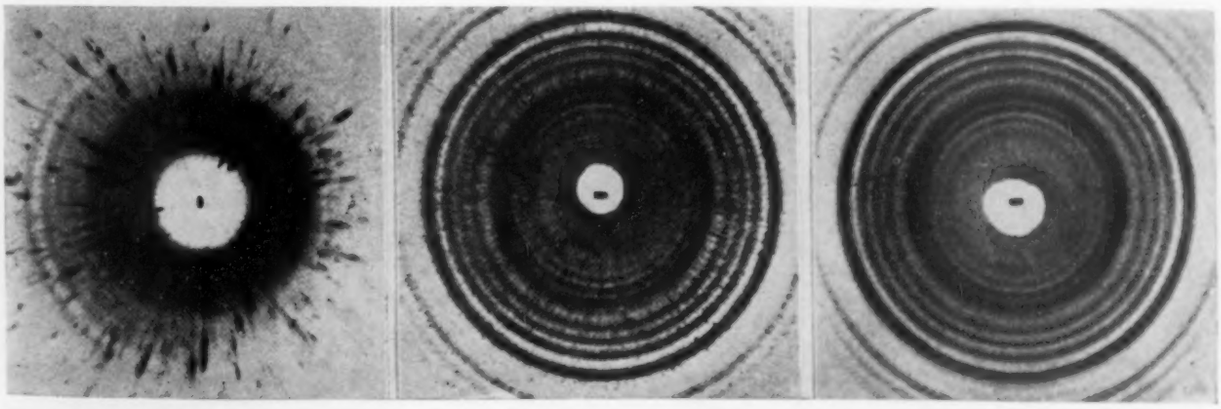


Fig. 4

Flame Preheating and Stress Relieving Arc-Welded High-Pressure Pipe Lines*

By P. T. Onderdonk† and W. Peterson†

THE application of arc welding to high-temperature and pressure pipe for steam lines suitable for temperatures of 950° F. and 1500 psi, or higher, produced a demand for suitable means of preheating the pipe and stress relieving the welding. The introduction of alloy steel and heavy wall thicknesses needed for the large size pipe to carry the volumes of steam and water required by topping turbine installations of 50,000 to 60,000 kw. capacity made it desirable to use such a means. The function of the preheat is to minimize shrinkage during the welding operation to preclude development of sufficiently high internal stresses to produce cracks either in the weld metal or parent metal adjacent the weld. The stress-relieving operation is a continuation of this same function by relieving such internal stresses in the completed weld sufficiently to prevent failure when additional stresses are imposed by external loads in service.

A number of methods of solving this problem have been developed and used for this purpose. Some are applicable to shop practice only and others may be used for either shop or field work. Those which appear to have received the most favorable consideration can be divided into essentially two classes, i.e., electric and flame methods. Those employing electricity are referred to as the resistance and the induction methods. The flame methods generally used are based on utilizing some of the more common fluid fuels such as fuel oil, kerosene, illuminating gas and oxyacetylene in a temporary or portable brick-type enclosure incorporating a suitable torch arrangement or in a multi-jet, ring-type burner.

* Paper presented at the Annual Meeting, A. W. S., Philadelphia, Pa., Oct. 20 to 24, 1941.

† Inspection Engineer and Junior Engineer, respectively, Consolidated Edison Co. of New York, Inc., New York, N. Y.

As a result of changing field erection requirements, a demand arose for supplementing or replacing the electric methods previously employed with a flame method, preferably of an improved nature, adapted primarily to field use. A study of available furnaces, burners and fuels led to the development of a very satisfactory method employing propane. A portable furnace to accommodate heating torches suitable for the use of this fuel was designed to permit readily mounting it for use on a pipe-to-pipe or pipe-to-fitting weld. The development of this equipment, the economic and physical factors influencing the selection of propane gas as fuel, and the experience obtained in actual field application of this method are described in some detail in this paper.

The furnace design was established on three basic requirements; i.e., to produce uniform temperatures without flame impingement on the pipe or weld, to be light in weight and portable, and to be adaptable for rapid assembly and requiring a minimum of time to place in operation. Figure 1 shows a drawing of the furnace finally adopted after completing a series of tests. It differs from the original principally in the shape of the torch openings which were redesigned to eliminate impingement of the flame on the refractory lining and the addition of a perforated sheet steel baffle. The materials used in its construction consist of a welded sheet steel outer case and an inner lining of molded high-temperature cement reinforced with spring steel wire. The case is of split and bolted construction so arranged as to provide an annular opening between it and the pipe to liberate the burned gases. A furnace suitable for 12-in. schedule 160 pipe was used for the experimental work.

Four gases were initially selected for consideration as fuels for this furnace. They were acetylene, propane,

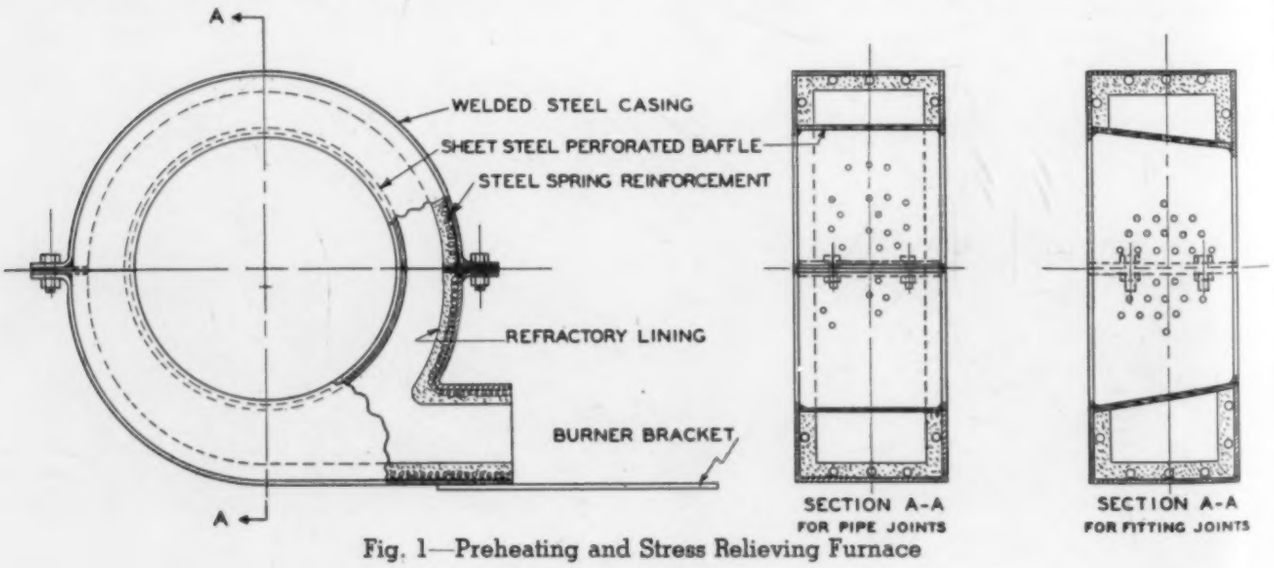


Fig. 1—Preheating and Stress Relieving Furnace

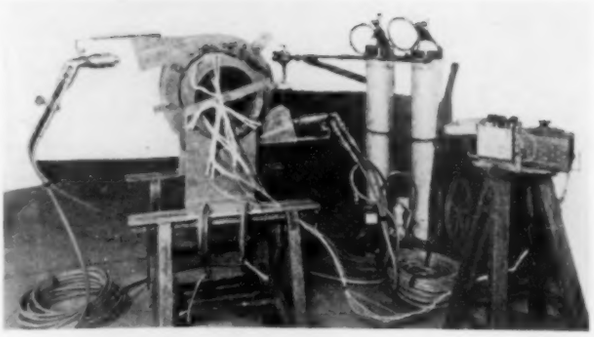


Fig. 2—Preheating and Stress Relieving Equipment for Test on 12¾ Inch O.D. Schedule 160 Pipe

butane and illuminating gas, but the latter two were rejected before any tests were made. Butane has a low vapor pressure at normal temperatures and quickly approaches freezing if withdrawn rapidly from the cylinder, necessitating the application of heat to obtain a satisfactory rate of vaporization. This additional equipment and controls are not convenient for field construction use. Illuminating gas was rejected because of its low heat content by volume which would require relatively large lines and flexible hose or the use of a compressor for increasing the pressure to permit the use of smaller lines and hose. In any case, a system of temporary gas headers and risers would be needed for distribution, adding to the congestion usually found on an erection job. Therefore it was decided to confine test work to the two remaining gases; i.e., acetylene and propane, both of which are available in cylinders that can be transported easily and are under ample pressure to permit the use of conveniently sized hose lines. A table of the more common properties of these two gases is included in the appendix.

Two types of torches were selected for use with the furnace. One was the standard oxyacetylene welding torch equipped with a No. 9 tip. The other was a standard preheating torch with a No. 10 tip designed for burning natural gas, but deemed to be suitable for use with propane gas. The selection of these torches for the experimental runs was dictated by the decision to confine the investigation to a comparison of oxyacetylene and propane with compressed air.

An arrangement of the test equipment consisted of the furnace provided with torches, the necessary fuel supply which in each case was available in steel cylinders, regulators to maintain constant gas pressure, and the required fuel metering and temperature recording instruments. A picture of this equipment is shown in Fig. 2.

The procedure for test was to heat the pipe from room to preheat temperature of 600° F. and maintain it sufficiently long to obtain desired data. The pipe was then heated to the higher stress-relieving temperature of 1250° F. and maintained to complete data readings. During this operation, the rate of gas consumption and total quantities of gases required at fixed pressures to attain and maintain the desired temperatures were measured. The temperatures were determined by means of iron-constantan thermocouples placed at several points on the inside and outside surfaces of the pipe. Table 1 shows gas quantities, rates and pressures derived from these tests. The rate of rise and distribution of temperature for three different combinations of torches and fuel are shown in Figs. 3 to 5. The data plotted in Fig. 3 are for an arrangement of two oxyacetylene torches having No. 9 tips and using oxyacetylene as the fuel mixture. Those shown in Fig. 4 are for an arrangement of two No. 10 preheating torches and those in Fig. 5, one No. 10 preheating torch using propane and compressed air as the fuel mixture. An analysis of these results

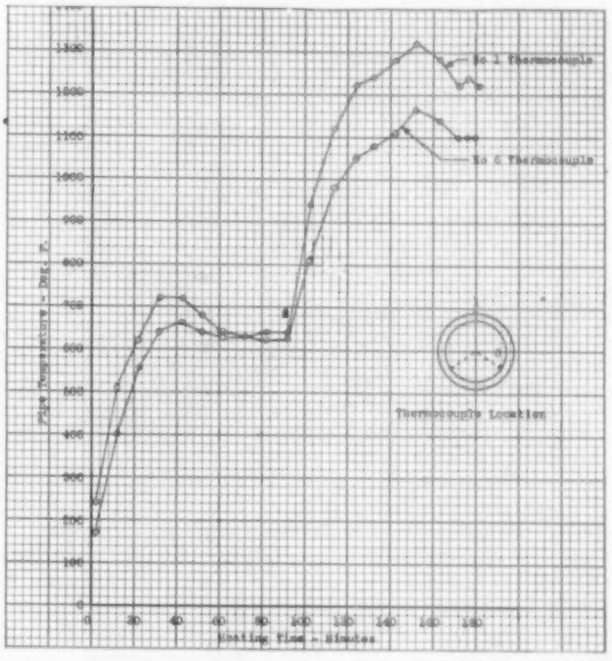


Fig. 3—Representative Curves of Temperature Changes During Tests on Preheating and Stress Relieving Furnace for 12-Inch Schedule 160 Pipe Using Two Oxyacetylene Torches with No. 9 Tips

Table 1—Combustion Rate and Total Consumption of Gases Determined by Test of Heating Furnace Applied to 12-In Schedule 160 Pipe

Type of Torch	No. of Torches	Gases Used	Gas Pressure, Lb. per Sq. In. Gage	Av. Combustion Rate, Cu. Ft. per Min.* To Maintain 600° F.	Av. Combustion Rate, Cu. Ft. per Min.* To Maintain 1250° F.	Av. Combustion Rate, Cu. Ft. per Min.* Max. During Test	Total Gas Consumption, Cu. Ft.* To Attain 600° F.	Total Gas Consumption, Cu. Ft.* To Raise Temperature from 600 to 1250° F.	Heating Time, Min. To Attain 600° F.	Heating Time, Min. To Raise Temperature from 600 to 1250° F.
Welding	2	Oxygen	12.5	1.1	1.1	2.0	24	116	20	60
No. 9 tip		Acetylene	7.5	0.5	1.0	1.5	20	88	..	..
Preheating	2	Propane	5.0	0.6	1.2	2.2	22	60	12	30
No. 10		Compressed air	85	...	...	...	..	...	..	..
Preheating	1	Propane	5.0	0.3	0.8	1.6	22	56	15	45
No. 10		Compressed air	85	...	...	...	..	...	..	..

* All values have been corrected to atmospheric pressure.

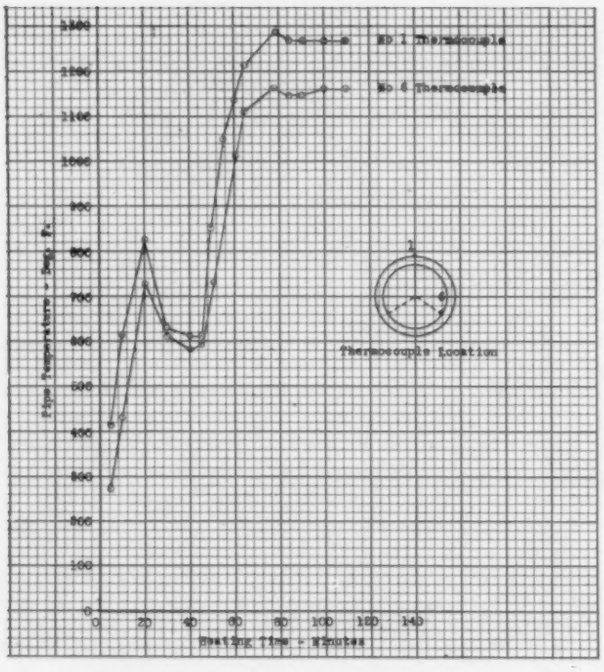


Fig. 4—Using Two No. 10 Torches Burning Propane Gas with Compressed Air

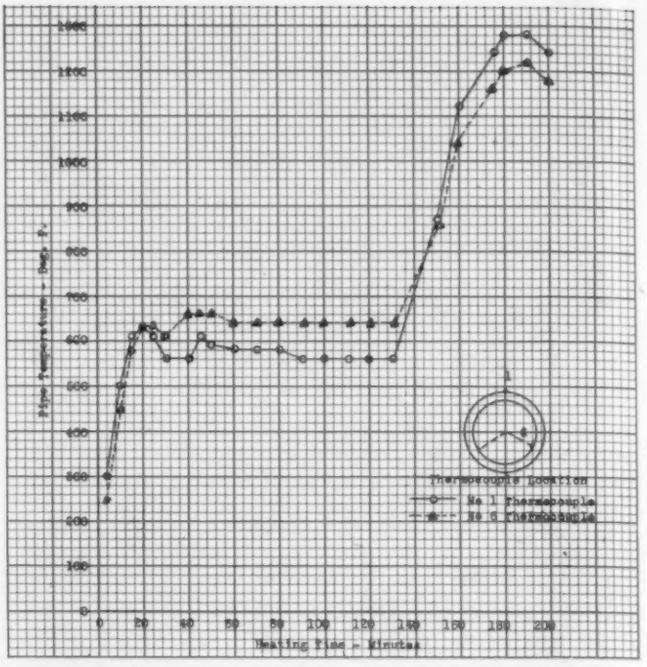


Fig. 5—Using One No. 10 Torch Burning Propane Gas with Compressed Air

Representative Curves of Temperature Changes During Tests on Preheating and Stress Relieving Furnace for 12-Inch Schedule 160 Pipe

showed that a single No. 10 preheating torch using propane with compressed air produced the most acceptable results. They indicated also that a smaller size torch might be used to somewhat better advantage, particularly on smaller size pipe. This was confirmed later in actual practice.

A cost study based on the test results obtained from the experimental work and anticipated field operations was made. This study showed that the use of propane gas with one burner would not only prove more economical, but also would be equally as practicable as oxyacetylene. Neglecting the compressed air cost which would be negligible as it is an incremental cost on most construction jobs, the cost of propane was estimated to be approximately 50% of that for oxyacetylene. While fuel consumption under actual field conditions was expected to differ from test values to some extent, it was recognized that the greatest variable in the calculation was the relation of unit fuel costs. The unit fuel costs used for this comparison were as follows:

Oxygen	0.9 cent per cu. ft.
Acetylene	2.31 cents per cu. ft.
Propane	1.75 cents per cu. ft.

When the equipment to be used for field construction was selected it was decided to make some minor changes to obtain better control of its operation. In Fig. 6 is illustrated an application to a 12¾ in. O.D., schedule 160 carbon molybdenum pipe-to-pipe weld and in Fig. 7 to a 14-in., schedule 160 carbon molybdenum pipe to valve weld.

The furnace shown in these illustrations is the same portable design as that outlined in Fig. 1. It is equipped with a No. 8 preheating torch instead of the No. 10 used for the experimental work and is controlled by ¼-in. needle valves in the propane and compressed air lines. The propane is supplied through a standard acetylene hose from four 297-cu. ft. (35-lb.) cylinders which are under 125 psi pressure. These cylinders are connected to a common manifold equipped with a standard pressure regulator to reduce this pressure and maintain it at 15 psi. The compressed air is supplied through an air hose typical of the kind used for air gun service.

Although no attempt was made to provide an automatic temperature control, it was considered desirable to provide a recording pyrometer with a suitable number of thermocouples to establish the proper rate of heating and avoid fluctuating temperatures. The recorder shown in the illustrations was mounted in a wooden case to protect against damage.

In order to accommodate the range of pipe sizes involved, it was necessary to build a range of furnace sizes. As a rule, however, one size of furnace was suitable for use on several sizes of pipe.

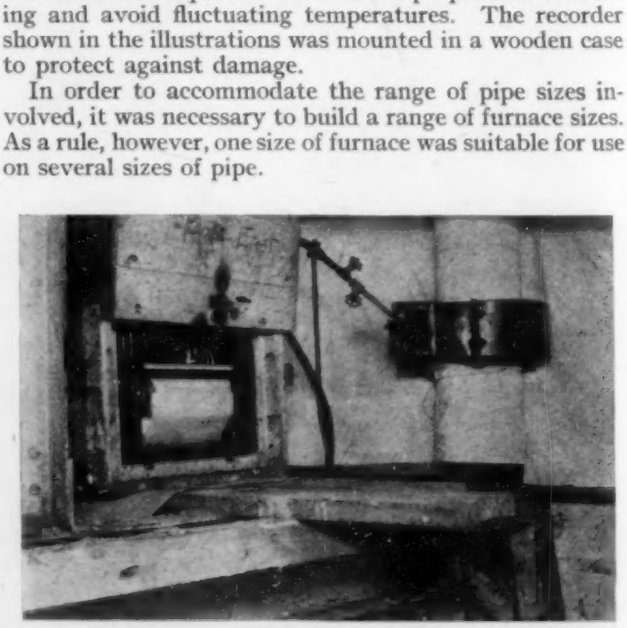


Fig. 6—Stress Relieving 12¾ Inch O.D. Schedule 160 Carbon Moly Pipe to Pipe Field Weld

Table 2—Unit Labor and Propane Consumption for Preheating and Stress Relieving High-Pressure Field Butt Welds

Pipe Size, In.	Thickness, In.	Carbon Steel			Carbon Molybdenum		
		No. Butt Welds	Man-Hours per Weld	Lb. Propane per Weld	No. Butt Welds	Man-Hours per Weld	Lb. Propane per Weld
4	0.531	8	2.3	4.2	16	3.5	13.0
6	0.718	10	4.7	7.5	16	6.5	19.7
8	0.906	34	7.8	10.7	56	11.0	27.5
10	1.125	28	11.8	14.3	18	17.0	35.7
12	1.312	8	16.6	18.0	54	25.0	45.7
14 O.D.	1.406	0	19.7	22.0	10	32.0	55.5

The manner in which this equipment was used is best conveyed by the following summary of the requirements established for preheating and stress relieving:

1. Preheating.—(*a*) All carbon steel welded joints with a wall thickness 1 in. or greater were maintained at a minimum temperature of 200° F. until stress relieving started.

(*b*) All carbon molybdenum steel welded joints with a wall thickness of $^1/_2$ in. or greater were maintained at a minimum temperature of 400° F. until stress relieving started.

2. Stress Relieving.—(*a*) All carbon steel welded joints with a wall thickness of $^3/_4$ in. or greater were stress relieved at a temperature of 1250° F. for a period equivalent to 1 hr. per in. of wall thickness.

(*b*) All carbon molybdenum steel welded joints with a wall thickness of $^1/_2$ in. or greater were stress relieved at a temperature of 1250° F. for a period equivalent to 2 hr. per in. of wall thickness.

The procedure for performing the required operations by this method consisted of slowly heating to the desired temperature a circumferential band centrally located with respect to the weld. The width of this heated zone was selected as approximately twice the width of the weld at the reinforcement.

It was intended initially to do all preheating by means of the furnace and slide it to one side while welding. It developed in practical application, however, that the necessary preheat in many cases could be accomplished with greater facility by manual application of two No. 8 torches. When the weld was completed and ready for stress relieving, the furnace was mounted in place. After the stress-relieving temperature had been maintained for the desired length of time, the rate of cooling was controlled by gradually reducing the torch to shut-off. At a temperature of approximately 800° F. the torch was removed and the port opening capped to permit continued cooling in essentially still air until ambient temperature was reached. A representative preheating and stress-relieving temperature record is shown in Fig. 8.

Special applications were devised during progress of the field work in the nature of modifications or additions to the intended procedure. One of these is described to illustrate the flexibility of the flame method.

The largest special heating furnace used was 48 in. O.D. x 22 in. wide, with a 3-in. molded refractory lining. Because of its size, the design incorporated two openings equipped with two No. 10 propane compressed air heating torches to maintain the desired distribution. This furnace was used to stress relieve welds made on boiler downcomer pipes approximately 28 in. O.D. x $1^1/_2$-in. thick. The preheating was done internally by means of a No. 10 propane compressed air heating torch fixed inside the downcomer pipe. The flame was directed at a metal disk with a diameter of about half that of the pipe and covered with refractory cement. The flame was deflected away from the disk establishing circulation in the direction of the pipe wall to maintain a constant uniform preheat temperature. This method of preheating enabled the welder to work continuously without the interruption which occurs when external heating is employed.

When the weld was completed, the internal torch was left in operation while the furnace was set up and stress relieving started. When it was completed, the external torches mounted on the furnace were shut off and the openings capped in the usual manner. The internal burner was left in operation to retard the rate of cooling until the temperature of the weld dropped to approximately 800° F.

There are a number of precautions which should be observed in the use of this method of preheating and stress relieving. First, as nearly a neutral flame as possible should be maintained at all times. Secondly, local or concentrated flame impingement should be avoided. This applies especially to acetylene which has a flame temperature appreciably higher than propane. These two precautions should not be relaxed in any way even though the furnace is provided with a perforated sheet steel baffle plate to minimize the effects of poorly controlled operation. Finally, thermocouples should be protected against direct flame impingement or heating from direct radiation. To guard against unreliable temperature readings, the thermocouples should be covered with shields. One type of shield suitable for this purpose is comprised of a half section of 1-in. steel pipe, 6 in. long, packed with refractory.

In order to express costs established under actual construction conditions it is desirable to indicate the extent to which this method was applied. A tabulation is shown in Table 2 which gives the number and size of

Fig. 7—Stress Relieving 14 Inch O.D. Schedule 160 Carbon-Moly Pipe to Valve Field Weld

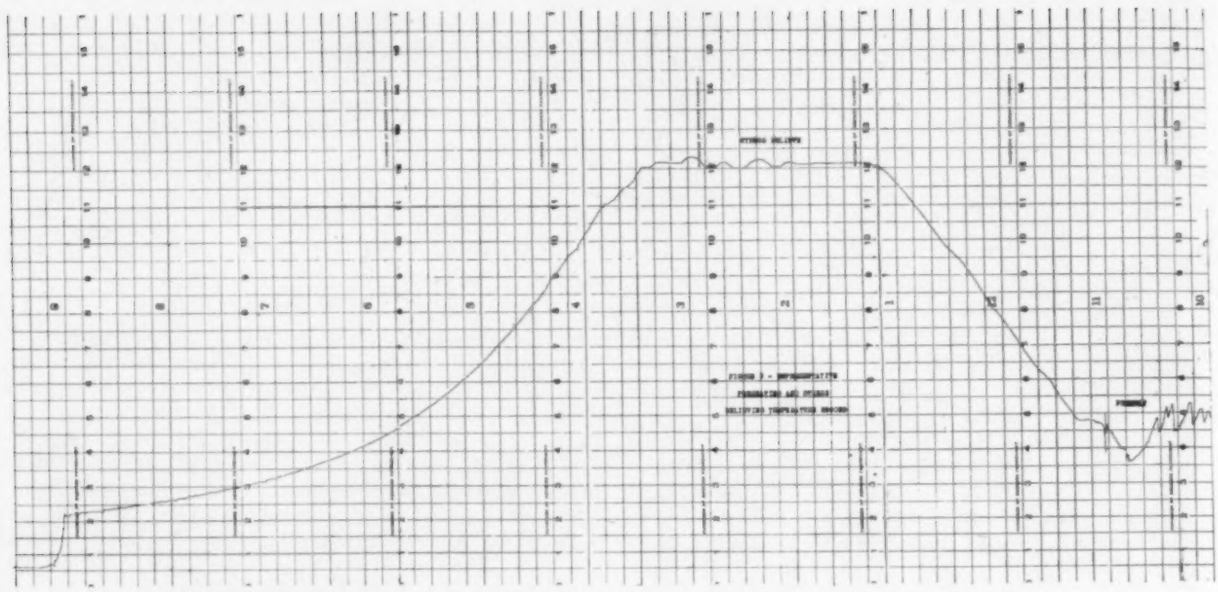


Fig. 8—Representative Preheating and Stress Relieving Temperature Record

Table 3—Unit Cost Ratios Exclusive of Equipment for Stress Relieving with Flame Method Vs. Electric Method in Terms of a 6-In. Carbon Steel Pipe Weld

	Stress Relieving Electric Arc Welds			
	Carbon Steel Pipe		Carbon Molybdenum Pipe	
Pipe Size, In.	Flame Method	Electric Method	Flame Method	Electric Method
4	..	..	1.42	5.20
6	1.00	3.08	1.67	6.05
8	1.22	3.32	1.93	6.68
10	1.44	3.56	2.57	11.14
12	2.03	3.81	4.52	11.88
14	..	..	5.73	12.62

high-pressure joints in both carbon and carbon molybdenum steel which were preheated and stress relieved. From records kept on the 258 joints shown in this tabulation there have been developed unit costs which it was deemed desirable to express in terms of man-hours and pounds of propane. These also are shown in Table 2. Presenting the data in this manner permits direct application to fluctuating or variable wage rates and fuel prices.

A comparison of these figures with those established from previous experience with electric methods of preheating and stress relieving showed that generally speaking, the electric methods were more costly. It should not be deduced from this statement that such a relation would prevail under all conditions, as it should be borne

Table 4—Properties of Acetylene and Propane

Properties*	Acetylene		Propane	
Series	Olefin		Paraffin	
Formula	C_2H_2		C_3H_8	
Molecular weight	26.015		44.062	
Lb. per cu. ft.	0.06971		0.1196	
Cu. ft. per lb.	14.344		8.365	
Sp. gr. air—1.000	0.9107		1.5617	
Heat of combustion	Gross	Net	Gross	Net
Btu. per cu. ft.	1503	1453	2572	2371
Btu. per lb.	21,572	20,840	21,564	19,834
Combustible	Cu. Ft./Cu. Ft.	Lb./Lb.	Cu. Ft./Cu. Ft.	Lb./Lb.
O_2 for combustion	2.5	3.075	5.0	3.631
N_2 for combustion	9.411	10.231	18.821	12.081
Air for combustion	11.911	13.306	23.821	15.712
CO_2 in flue products	2.0	3.383	3.0	2.996
H_2O	1.0	0.692	4.0	1.635
N_2	9.411	10.231	18.821	12.081
Ignition temperature ° F.	763–824		965 Approx.	
Flame temperature ° F.	5630		3497	
Explosive limits	Lower	Upper	Lower	Upper
Per cent in air	2.5	80	2.4	9.5

* Third Edition of *Combustion*, 1932, and *Fuel Flue Gases*, American Gas Association.

in mind that it applies to field construction work only and in a specific geographical area. The order of the difference in costs between the flame method using propane and the electric induction method is shown in Table 3. These differences are given in terms of the cost of a 6-in. schedule 160 carbon steel joint expressed as unity. This same tabulation is also arranged to permit a comparison of the flame method costs for the same range of pipe sizes.

The conclusions reached from experience with the flame method of preheating and stress relieving using propane and compressed air in field construction work on two high-pressure superposed turbine installations are:

1. The method is practical for field operations.
2. It is readily portable and compact.
3. It can be adapted readily to a variety of conditions at small cost.
4. It is very acceptable from a safety viewpoint.
5. The cost of the equipment is relatively low, particularly with respect to the electric methods.
6. It is very economical with respect to labor and fuel costs and may effect a substantial saving over other methods. This saving may range from $7000 to $10,000 on a job where the preheating and stress-relieving costs are of the order of $15,000.
7. In addition to field application it should be equally applicable to shop use where the volume of work would not warrant a large investment or where special problems have to be met.
8. Since the initial cost is low and because its simplicity of construction and operation require only a small amount of material with a priority rating, it should serve in many instances as a satisfactory substitute under the present emergency for other methods.

Some Radiographic Aspects of Aluminum Spot Welds*

By Robert C. Woods† and Stuart L. Rich†

AMONG the vast number of possibilities for production speed-up, few play a more important role than the subject of spot welding, in general, and in particular, the spot welding of aluminum structures. In fact, it is widely conceded that this art, properly applied, undoubtedly holds the answer to many of the most knotty industrial problems now facing American manufacturers.

The volume production confronting the aircraft industry has tended toward the widespread acceptance and rapidly increasing amount of this method of fabrication, and equipment manufacturers in the past two or three years have been striving toward perfection of apparatus which would produce welds of consistent quality to meet the exacting demands of aircraft standards.

By these standards, a sound spot weld must meet the following requirements:

1. The surface indentation of the exterior or exposed surface must be held to a minimum, approximately 0.003 in. for the lighter gages and not exceeding 0.005 in. on gages between 0.064 and 0.120, inclusively.
2. The process shall be so controlled that there will be no sheet separation, or gap between faying surfaces.
3. The exposed surfaces of spot welds must be free from cracks due to lowered corrosion and fatigue resistance.
4. There can be no discoloration of the exposed surface—an indication of excess heat.
5. There shall be no penetration of the cladding because of a consequent reduction in corrosion resistance.

Control and regulation of the foregoing defects can be determined by visual examination and immediate action toward corrective measures taken.

Like any other process, the field of aluminum spot welding, by nature, divides itself into a series of individual problems, not the least being satisfactory tests to determine the soundness of completed welds. This inspection angle in turn may be split roughly into destructive and non-destructive tests.

Destructive tests on aircraft components are obviously not practical. For this reason, it is customary to run off a series of control specimens at the start and during the fabrication of production aircraft parts. These control specimens are subjected first to quick sectioning tests to determine the concentricity of the nugget about the interfaces and for signs of internal cracks and/or porosity within the nugget radiating from the normal to the axis of the interfaces. Other tests on specimens are conducted to determine consistency of shear strength which must be in excess of a minimum prescribed by government agencies for the materials and gages involved, fatigue tests and accelerated corrosion tests in a vaporized salt atmosphere.

However, it is not our intent here to treat the subject of destructive testing, since such work has attained a

* Presented at the Annual Meeting, A. W. S., Philadelphia, Pa., Oct. 20 to 24, 1941.

† Physicist and Welding Engineer, respectively, Bell Aircraft Corp., Buffalo, N. Y.

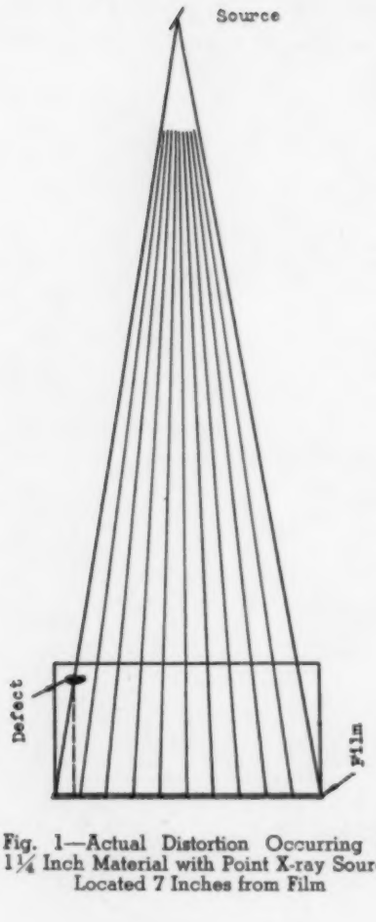


Fig. 1—Actual Distortion Occurring in 1¼ Inch Material with Point X-ray Source Located 7 Inches from Film

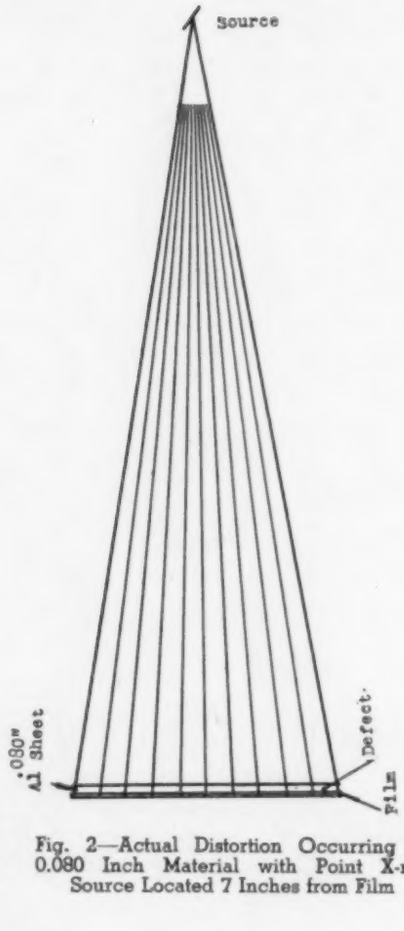


Fig. 2—Actual Distortion Occurring in 0.080 Inch Material with Point X-ray Source Located 7 Inches from Film

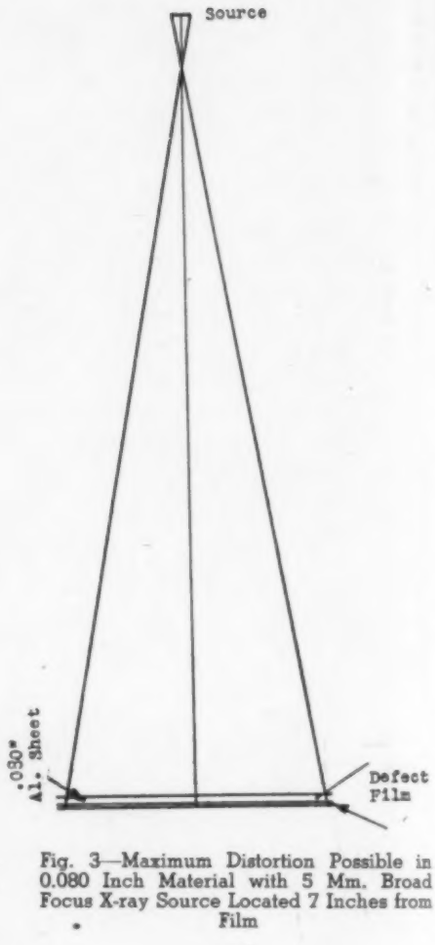


Fig. 3—Maximum Distortion Possible in 0.080 Inch Material with 5 Mm. Broad Focus X-ray Source Located 7 Inches from Film

higher degree of refinement than has the non-destructive. In addition, many of our more eminent colleagues are now studiously engaged in further perfection of the physical testing phase and new data are flowing in a never-ending stream from their laboratories.

There still remains, however, the non-destructive test which, in the last analysis, is the only one possible of application to completed structures. Moreover, of the various types of non-destructive tests, none except the X-ray actually enables the operator to perform a visual study of the weld interior. Just what ultimate sensitivity this method can achieve and how accurately the results may be interpreted are both questions which must be answered by more extensive research. Work to date, nevertheless, has convinced the authors that the X-ray method holds promise of becoming far and away the most sensitive test for routine revelation of spot-weld soundness.

Accordingly, this field is now being pursued in our laboratory with utmost energy. But pending more precise interpretative results, let us briefly examine those physical principles which control our present radiographic techniques and will, in the future, produce finer ones.

There has been considerable discussion and argument recently relative to the optimum X-ray technique for inspection of aluminum spot welds. For instance, the statement was recently made that at 50 kv. a small focal spot X-ray tube operating for 40 sec., 36 in. from the film, is radiographically far superior to a larger focal spot operating for 90 sec. at a 50 in. distance. Unfortunately, such a statement is absolutely meaningless without mention of type of equipment, type of X-ray tube, thickness of specimen examined, kind of film used, etc.

To understand better the various factors involved, let us make a brief survey of some of the whys and wherefores pertaining to industrial radiography. While it may be an old story to many, it is hoped there still may be a few to whom this material will prove of assistance.

Up to a certain point, an X-ray beam can be visualized as composed of two parts, (1) wave lengths or corpuscles of energy, and (2) intensity. Variations in radiation wave lengths emitted from a given X-ray tube depend on the potential applied across the tube. These wave lengths, in turn, determine the penetrating power of the rays, the shorter waves passing more readily through matter than the longer ones. In passing through an aluminum spot weld, for example, a definite percentage of X-rays are deflected from their original course in accordance with a relation existing between the wave length of the ray and the distribution of material particles lying directly within their path. In some cases of collisions of X-ray photons and material corpuscles, none of the energy directed at the weld completely traverses it. On the other hand, wherever an area of lowered density exists—e.g., a void or crack—the rays encounter a section less densely populated by solid obstacles and thus continue their travels more readily.

Now the absorption of X-rays in metals is a function not only of the energy wave length, but also of the denity and atomic weight of the metal. Since aluminum is a light element, its absorption coefficient is low compared to that of iron or copper, and small variations in its structure or density have relatively little effect on shorter wave-length radiations, radiographically speaking. To

put it more succinctly, the higher the X-ray tube voltage used for examination of thin aluminum objects, the worse the radiograph.

In practice, the most revealing radiograph will generally be obtained by recourse to the lowest possible voltage, but for production work, the exposure times then become unduly long and some compromise must be made.

The time factor is almost entirely up to the radiographer. If he feels the detail gained by long exposures is not worth the holdup in production, shorter exposures can be used even though something of quality is thereby sacrificed. And since no definite standards have yet been drawn as to what we must see in a spot-weld radiograph, the subject is still open to argument, although it is pretty generally admitted that the best is still not good enough.

Turning from wave length to the question of intensity, we find this is the simplest angle to deal with since it is merely the quantity of radiation present in any selected volume of space. This quantity is directly controllable by the X-ray tube current as indicated on the milliameter provided on all X-ray machines. The relation between intensity and radiation traversing a sample in a certain time is fairly direct, so that radiographic techniques may be confidently based on the product of time and intensity. That is, the same X-ray tube and machine operating at, say, 40 kv. should produce comparable radiographs of an object whether the exposure is for 10 min. at 5 milliamp., or for 5 min. at 10 milliamp., the product being 50 milliamp.-min. in either case. Unfortunately, however, 50 milliamp.-min. has significance only when referring to a specified X-ray tube and machine. Variations of output between two machines operating at the same voltage and current may amount to more than 10% and a difference of 15–20% is not unusual between two X-ray tube outputs. Some of the factors producing this discrepancy are due to inherent characteristics of the electrical circuits, while other causes are variation in thickness of X-ray tube walls, condition of target and previous treatment of the tube.

Therefore, no one can define with certainty the optimum exposure times or intensities for any spot-weld radiograph and feel sure these values obtain for any machine or tube other than those in his own laboratory. Although this situation is less noticeable at the higher voltages, it can become extremely acute in the lower ranges most widely used for aluminum work.

The problem of target to film distance has been given considerable publicity but in the realm of aluminum spot-weld work, the subject is not of much importance. Almost any reasonable distance, from 10 in. on up, is satisfactory where only one or two welds are to be examined. If a long string of welds is to be radiographed on a single film, then it is probably wise to keep the target at least 20 in. from the film.

Where relatively thin specimens are to be inspected—as is true in the case of aluminum aircraft spot welds—the only significant effect of distance is intensity change, the amount of radiation reaching a given point on a film being inversely proportional to the distance. That is, of course, the quantity of X-rays producing a photographic image at one foot is four times as great as at 2 ft. Now, assuming the radiation is emitted from a point source, the rays theoretically spread out evenly in all directions, so that at any two spatial points equidistant from the source the same quantity of X-rays should exist. Because of X-ray tube construction, this is not quite the case, but it may be considered so within the limits of practical radiographic techniques. This means, then, that when an X-ray beam falls on a plane surface located tangential to the emitted sphere of radiation, all rays striking the plane will not meet it at the same angle. Actually, only the ray traversing the line of shortest distance from source to plane will form a right angle with the plane. All other rays will arrive at smaller angles of incidence.

In the radiography of relatively thick materials at short distances, only the area directly in the path of the tangential ray can be truly recorded on the film, the remaining areas undergoing some distortion due to the arrival of variously angled rays, as in Fig. 1. However, with examination of a thin aluminum specimen—say, 0.064 in.—the angulated ray travels only a fraction of an inch between the upper and lower surfaces of the metal, as in Fig. 2. Of course, even in this minute distance there is a theoretical distortion, but if our present radiographic techniques were of such high quality as to make this condition serious, it would indeed be something to write home about.

Somewhat along the same line is the argument relative to large and small focal spot X-ray tube targets. It has been contended that there is a vast advantage to be derived from use of fine focal spots over broad ones. While this is undoubtedly true for wide extremes, within the normal range of radiographic target sizes, there is little difference for inspection of thin materials. Almost the same points previously mentioned in the distance discussion also apply to the focal spot problem. That is, for reasonable distances, those rays emitted from different target areas are traveling at various angles, but they have a slim chance to cause distortion in thin samples. This is especially so when a few spot welds are examined and the film area to be covered is small. Furthermore, when working within the ordinary range of target-to-film distances, most of the rays emitted at undesirable angles fall well outside the radiographic area and take no part whatever in formation of the photographic image. (See Fig. 3.)

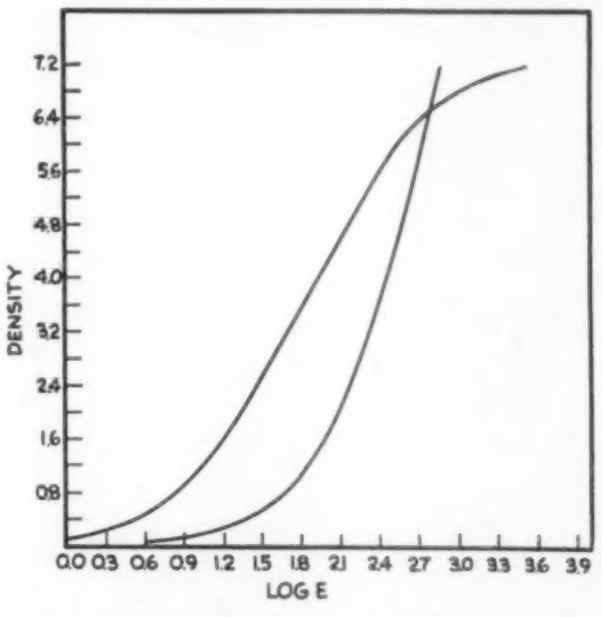
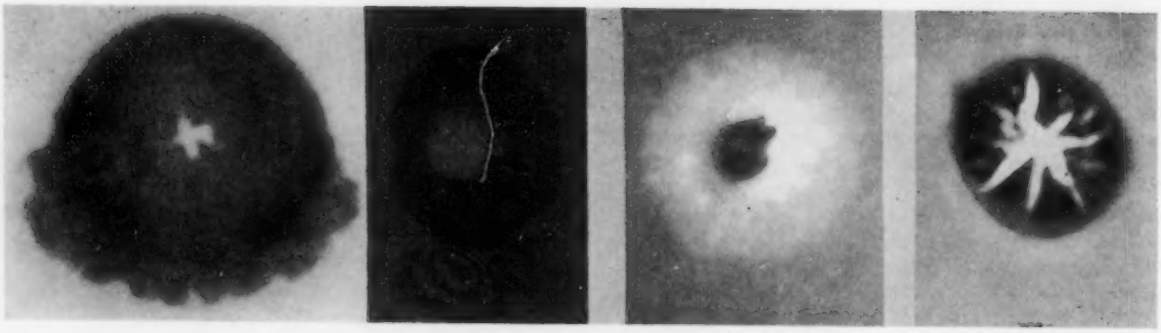


Fig. 4—Two Characteristic Curves of X-Ray Films with Density (Photographic Blackening) Plotted Against the Logarithm of Exposure Which Represents Energy Delivered to Film

Curve on left shows higher speed film since less energy is required to start photochemical process. However, once started, right-hand curve climbs more steeply, thus shows higher contrast than first film, because less energy is needed to produce large density changes. Result, small changes in X-ray absorption from point to point of radiographed specimen will be more apparent when recorded on right-hand film



5 6 7 8

Fig. 5—Spot-Weld Radiograph of Two 0.040-In. Aluminum Sheets Showing Small Radial Center Cracks with Inter-Sheet Peripheral Splatter

Fig. 6—Radiograph of Aluminum Spot Weld Showing Center Unfused Area. Fused Area Absorbs X-Rays to a Greater Extent Than Either Base Metal or Unfused Spot Indicating Metallurgical Change

Fig. 7—Radiograph of Aluminum Spot Weld Showing Extreme Porosity and Gas Pockets

Fig. 8—Radiograph of Aluminum Spot Weld Showing Case of Extreme Radial and Peripheral Cracking

Turning from discussion of strictly X-ray factors, we find the selection and handling of photographic films to be of vital importance in this field. As is well known photographic emulsions vary considerably in such properties as speed, contrast and grain size. It is our contention that the optimum film for X-ray study of aluminum spot welds will combine maximum contrast with minimum grain size. The question of film speed can be disregarded for the moment

The photochemical reaction of one film may be far faster than that of a second, yet the first may have superior contrast, as illustrated in Fig. 4. Contrast is that emulsion property which results in the largest possible blackening variation in response to small changes in radiation intensity. That is, using a high contrast film, small changes of X-ray absorption from point to point in a weld will produce more readily observable changes in the finished picture.

Of equal importance is the emulsion grain size. Large grain films tend to give the recorded image a fuzziness and unsharpness of detail which confuse the eye and even lead to a diagnosis of porosity or intergranular fracture in the radiographed specimen, especially if the film is viewed under magnification. Of the various films tried in our laboratory, we have found the no-screen X-ray type satisfactory for production purposes if the detection of large cracks and serious porosity are the only defects to be sought. Going to the other extreme, if minute changes in the weld metal are to be visualized, the spectrographic emulsions—such as Eastman No. 548-0—are used, even though exposure times may be of the order of one quarter to half an hour. However, where it is desired to reduce exposure times, but retain as much fineness of detail as possible, we would recommend Eastman Process Film. This is a single emulsion photographic film which combines excellent contrast with a grain size permitting easy study under magnifications up to 15 or 20 diameters. While its speed is probably one-fifth that found in regular X-ray film, its superiority in other directions makes up for its slowness. In practice, all our test aluminum spot welds are routinely radiographed on Process film and the resulting images studied under some enlargement.

Nevertheless, the advantages gained through use of fine grain may be completely nullified in two ways: by use of calcium tungstate intensifying screens or by overdevelopment. In the first case, calcium tungstate grain size is so immense relative to the emulsion grain size that each fluorescing grain exposes numerous emulsion grains and thus causes image unsharpness. Overdevelopment not only produces chemical fog, but also causes clumping of emulsion grains, thereby giving the effect of a large grain film. This is especially so when a fine grain film is developed in a coarse developer such as is commonly used for X-ray work. Nevertheless, X-ray developer lends more contrast to a film than the usual photographic solutions and a happy medium can be hit by underdeveloping a fine grain film in X-ray developer. For example, if the regular time for processing X-ray film in an X-ray type developer is $4^1/_2$ min., Process film developed for $2^1/_2$ min. in the same solution gives excellent results.

Degree of enlargement of the final radiographic image more or less depends on personal choice and the size of defect it is desired to find. For instance, viewing a radiograph at 10 diameters yields information on the over-all appearance of the weld, and shows up quite small cracks. On the other hand, microscopic examination at, say, 50 diameters with a micrometer eyepiece allows study of small areas and actual measurement of crack sizes.

The authors realize, of course, that all efforts to secure finer techniques for making and viewing spot-weld radiographs are utterly useless unless the resulting picture means something to the viewer. And it is freely admitted that insufficient work has been done on the interpretation of spot-weld radiographs to allow establishment of standards. At the moment, study of spot-weld X-ray films will reveal the presence of cracks and it permits their measurement; it will disclose various conditions of porosity, any pronounced chemical segregation, inclusion of foreign material and splatter as well as the detection of unfused areas. Many of these conditions are readily apparent in the radiographs included here. But to date, we are unable to point to any radiograph and make an accurate guess as to what the sheer strength or fatigue resistance of the weld will be. Perhaps that condition is too much to expect of X-rays and will never come to pass, but the authors view the future of this research endeavor with considerable optimism.

Machine Flame Cutting in Shipbuilding*

By E. R. McClung†, and H. L. Wagener‡

THE applications of the machine flame-cutting process in the shipbuilding industry are both numerous and varied and the scope of such operations is being steadily extended from one day to the next. Those who were not acquainted with the relatively limited use of machine flame-cutting equipment just a few years ago often wonder just how shipyards were able to operate without the benefit of comparatively recent developments. The simple fact of the case is that uses of machine flame cutting have developed hand in glove with the extended use of welding processes. For proof of this, one need only look at the many newly established yards which are preparing nearly all, if not all, of their material by means of flame cutting for incorporation into the ship by welding.

New York Shipbuilding Corporation, as an older established yard set up originally for riveted fabrication, has not gone to quite the extent, in a few respects, as some of the newer yards, principally those engaged primarily in merchant construction. In many other respects, however, this corporation has been a leader in the extension of flame-cutting processes to new construction and in developing new designs, jigs, fixtures, etc., for automatic or semi-automatic applications. Inasmuch as these extensions have been largely on naval construction, discussion of some applications must be omitted because of their restricted nature. However, the cases covered below may be considered as representative of many of the uses of the machine flame-cutting process as applied to naval and marine construction, including a number of special applications developed by this corporation.

1. *Shop Operations.*—(*a*) Straight line cutting and plate edge preparation in the shops are done with single or multiple blowpipe set-ups to prepare grooves for hand welding or Unionmelt welding and, in certain cases, to prepare square edges for riveted connections. For some years the relatively large planer capacity at this yard stood in the way of the use of machine flame cutting for such work; but recently, with machine tool operations invariably scheduled for many weeks and sometimes several months ahead, the major portion of the preparation for welding has been done by flame cutting. The general applications of straight line cutting are well known to the trade and need no detailed discussion herein.

(*b*) The preparation of special structural shapes represents one of the most extensive shipyard flame cutting applications. The shops keep several machines in operation ripping I-beams and H-beams in half to produce two T-bars, and removing flanges or reducing flange width of beams and channels. Using different machines in each case, this latter operation can be done with the web of the beam either horizontal or vertical. In removing flanges, the results demanded depend upon the use to which the shape is to be put. For example, a flame-cut edge which is to be caulked after riveting might naturally require a smoother cut edge than one on which a weld would be deposited. Figure 1 shows a flange-cutting operation, with the beam web vertical, using a machine riding on a separate track. In this case, the distance of the machine from the beam web (and therefore the location of the cut with respect to the web) is maintained by a distance roller attachment. Figure 2 shows a similar operation being performed using a machine riding directly on the beam itself. Figure 3 shows a beam-ripping operation using the same machine shown in Fig. 1. The beam being

Fig. 1—Flange Cutting Operation—Web Vertical

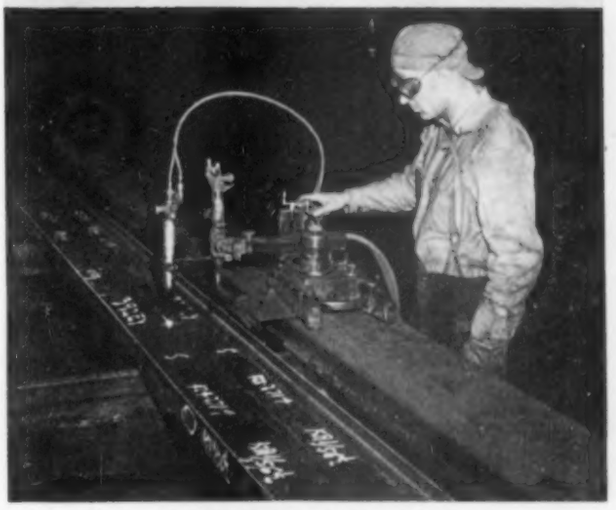


Fig. 3—Beam-Ripping Operation

* Presented at the Annual Meeting, A. W. S., Philadelphia, Pa., Oct. 20 to 24, 1941. This paper represents only the personal opinions of the authors and in no way reflects the official attitude of the Navy Department.

† Assistant Supervisor of Welding, New York Shipbuilding Corporation, Camden, N. J.

‡ Assistant Foreman, Hull Department, New York Shipbuilding Corporation, Camden, N. J.

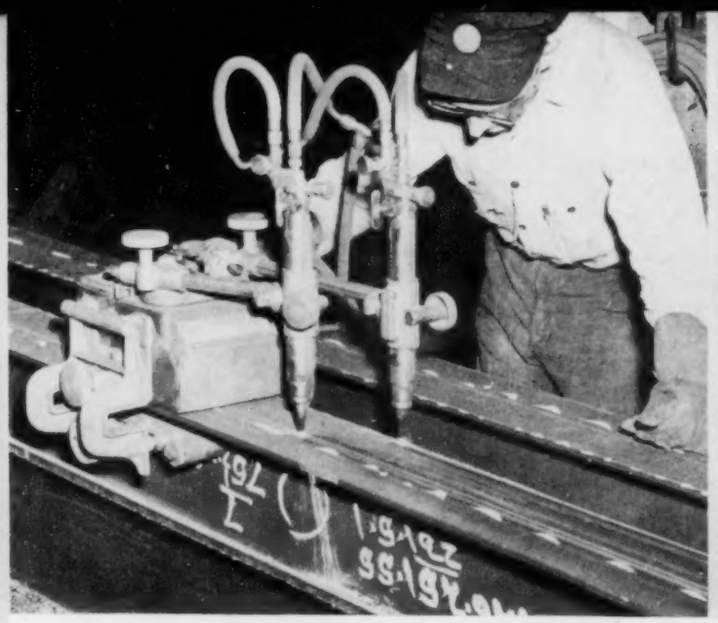


Fig. 2—Flange Cutting Operation

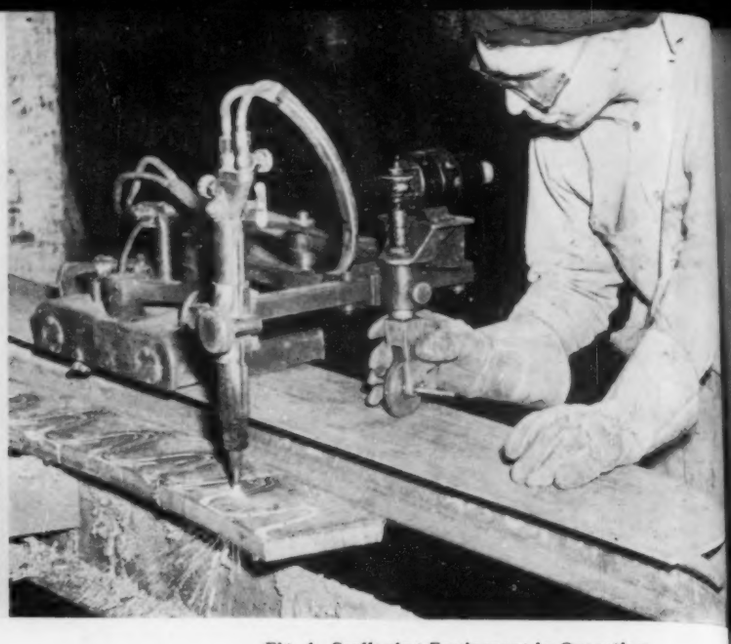


Fig. 4—Scalloping Equipment in Operation

cut happens to be a Junior beam, which fact accounts for the distortion evident.

(*c*) Scalloping of butt straps, seam straps, angle flanges, beam flanges, etc., is extensively done as a weight-saving proposition in riveted construction and to give increased linear weld footage where desirable in welded construction. This operation is performed by a special single blowpipe machine (the original specifications and arrangements of which were first worked out at New York Shipbuilding Corporation) which follows the layout line on material to be cut. The work can be done from prepared templates under certain conditions, but wide variations in rivet size, rivet spacing, scallop pitch, etc., limit the use of templates rather drastically. The equipment mentioned above produces an edge satisfactory for caulking except in the case of scalloped edges in certain air-hardening or quench-hardening steels which must have the flame-cut edge either ground back or be locally flame softened or the entire member be reheat treated. Figures 4 and 5 show the scalloping equipment in operation. Figure 6 shows a completed scalloped strap. Generally speaking, when scalloping butt straps as shown by Figs. 5 and 6, it is advantageous to scallop both edges simultaneously to minimize distortion. However, a great many structural members require scalloping of only one edge and these must invariably be straightened after cutting. The use of the special scalloping apparatus has resulted in very substantial cost reductions for the preparation of these edges by eliminating the necessity for chipping or grinding of a rough cut edge and for most subsequent straightening operations.

(*d*) Shape-cutting applications find great favor in the shops and a number of medium and small size shape-cutting machines, rigged for two- or four-blowpipe operation, are in constant use. The variety of shapes which can be produced from templates or independent layout in this way is well known. The number of oddly contoured plates, brackets, flanges, gussets, etc., which go into a naval or merchant vessel is astounding, even to those in constant contact with the work; hence the extensive application of shape-cutting equipment. Merchant yards find applications for the larger size shape-cutting machines in fabricating frames, webs and other large plate sections; in naval vessel construction, the changes of hull shape are more severe and there is very little repetitive work of this type. Consequently, naval building yards have somewhat less need for the larger machines. Figure 7 shows the cutting of frames for a merchant vessel using one of the larger machines. Figure 8 shows the cutting of shaped lightening holes and crosshead slide openings in a heavy forging using one of the medium-sized machines which are somewhat more adaptable to strictly naval work than are the large ones. Figure 9 shows the cutting, using four blowpipes simultaneously, of intricate shapes. Figure 10 illustrates the adaptability of shape-cutting machines to other work, this figure showing a straight line cutting job on a heavy section, a job which has been accomplished with a minimum of set-up time. Manual, magnetic and track template tracings depending upon which appears to be most suitable for the particular job at hand are used for various shape-cutting operations.

(*e*) Cutting of elongated manholes in floors, longitudinals and similar members is done using a straight line cutting machine with special attachments, guided by templates. Nearly all such holes in a ship are of a few standard sizes and only a minimum number of templates are required. Figure 11 shows a cutting machine set up with the template for performing this operation. The blowpipe is mounted, through a pivot arm, on a standard portable cutting machine. The machine itself traverses a circle about an offset radius rod, but the blowpipe, through a roller attachment, follows the

Fig. 5—Scalloping Equipment in Operation

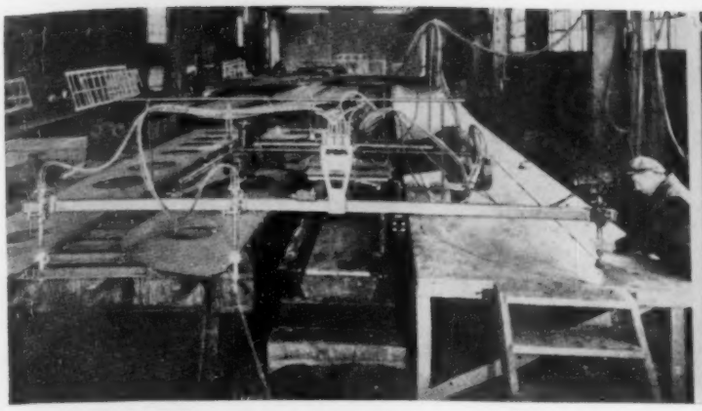


Fig. 7—Cutting Frames for a Merchant Vessel

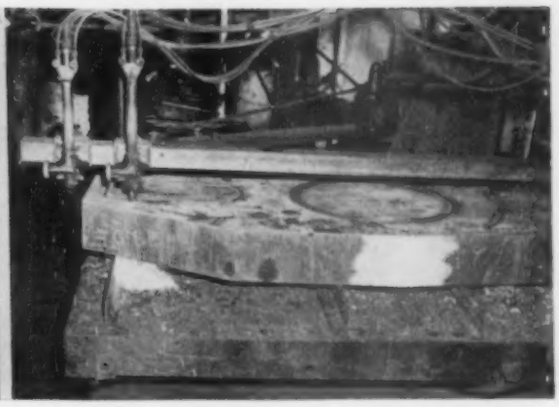


Fig. 8—Cutting Shaped Lightening Holes

template which can be of any shape falling entirely within the radius of travel of the machine.

(*f*) A rather obscure but interesting application of the simple portable cutting machine is in cutting square edges on heavy sections preparatory to thermit welding. This is all straight line cutting of heavy sections from 3

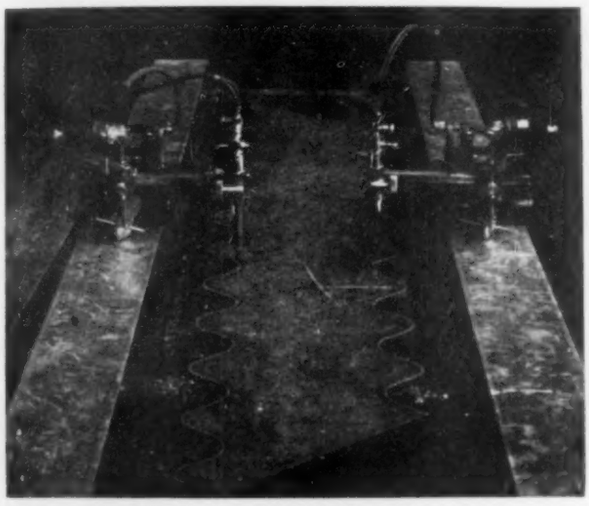


Fig. 6—Completed Scalloped Strap

in. up in thickness. The thermit weld is made directly to the flame-cut surface. New York Shipbuilding Corporation pioneered the use of thermit welding for heavy section castings in new naval construction and it is interesting to note that this use of thermit welding would not have been feasible without the adaptability of the flame-cutting process.

(*g*) One phase of machine flame cutting which has probably not been fully explored by many shipyards is the method of stack cutting. Stack cutting offers the possibility of substantial savings in the preparation of repetitive shapes but it does require a large amount of preliminary work in arranging material and unless the plating involved is relatively light so that an extremely large number of plates can be cut at one time, there is some doubt as to the economies which can be derived. Furthermore, in the light of the present situation regarding material deliveries, it is frequently impossible to stock material far enough ahead to have it available for stack cutting.

(*h*) New York Shipbuilding Corporation has made extensive use of J and U-groove joints for heavy welding and has pioneered the use of these grooves for many classes of work in naval construction. In heavy sections, most grooves of this type which have been cut in the yard have been prepared by flame gouging whether for partial penetration welds or for full penetration welds. Of course, if material is on a planer for other work, the groove is usually planed. Two methods of flame gouging are used, with material thickness generally being the determining factor in the choice of method.

1. For groove depths above $1^1/_2$ in., the straight line gouge, followed by a bevel cut, is used. This is the method described by Mr. E. V. David in the July 1941 issue of THE WELDING JOURNAL. This method is quite satisfactory for the majority of work encountered but frequently a certain amount of grinding at the junction of the initial groove and the bevel cut is required. Also, the initial gouging operation is sometimes quite critical, particularly when working with steels which may contain concentrations of alloyed elements or which may have internal defects.

2. Most of the gouging work for naval and marine construction requires grooves to be prepared to a depth

Fig. 9—Cutting with Four Blowpipes

Fig. 10—Straight Line Cutting on a Heavy Section

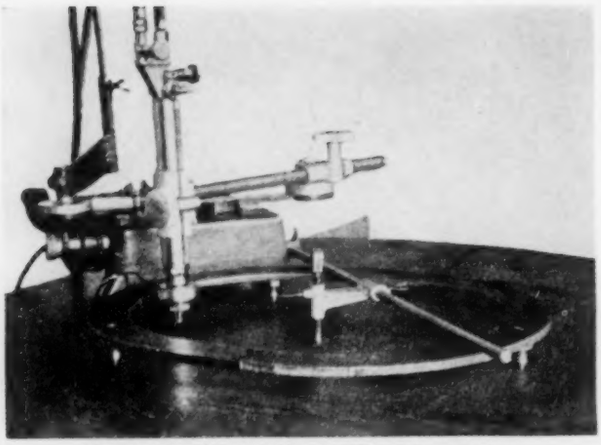


Fig. 11—Cutting Machine Set Up with Template

of $1^1/_2$ in. or less. For these grooves, the procedure is to first make a bevel cut with a slightly greater bevel angle than is required for the final groove and follow up with a washout gouge which can be adjusted to give approximately the included angle desired and which requires little or no touching up afterward other than cleaning off a lightly adhering slag. This method is less subject to technical difficulties than the "gouge-and-bevel" procedure and is favored by New York Shipbuilding Corporation for the majority of its work.

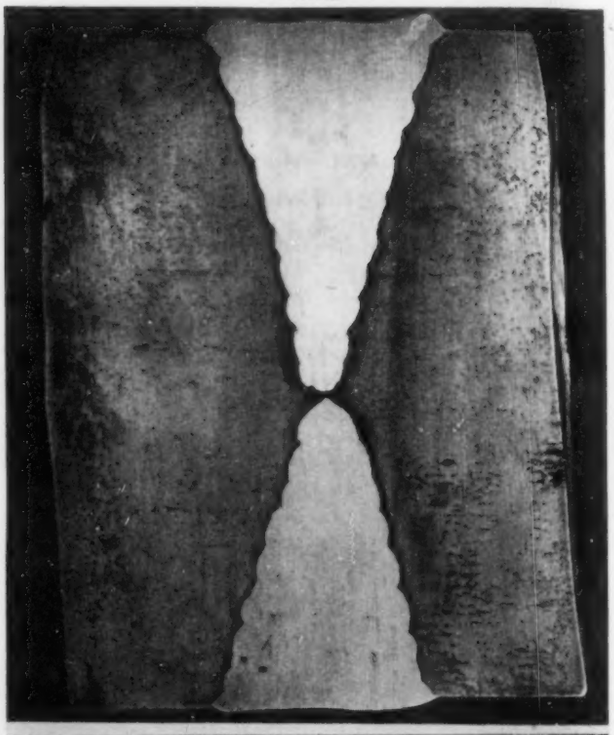
Figure 12 illustrates a weld made in a double U-groove prepared by the "gouge-and-bevel" method given above. Figure 13 shows the initial bevel cut for a partial penetration weld made by the second method described above and Fig. 14 shows the operation of washing out the groove to give the desired final preparation.

The preparation of grooves is principally a shop operation; hence its inclusion under that heading. However, a substantial portion of such groove preparing is done in the field immediately prior to assembly in the ship.

2. Field and Ship Operations.—(*a*) In order to prepare straight line vertical bevels for welding and to cut the vertical straight line portions of beveled openings in bulkheads, a special vertical cutting machine has been developed. Essentially, this consists of a blowpipe supported on a helical shaft and motor driven. This machine finds large-scale application on the above work and materially reduces the cost for the job by eliminating the necessity for extensive grinding operations following flame cutting. At the present time, experimental work is being done on a replacement design to do the same job without using the mounting rig and motor drive required by present equipment.

Fig. 14—Washing Out the Groove

Fig. 12—Weld in Double U Groove Prepared by "Gouge-and-Bevel" Method



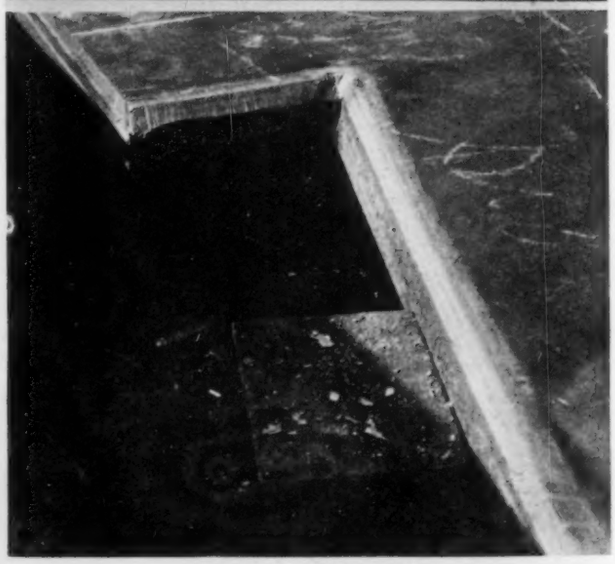


Fig. 13—Initial Bevel Cut

(*b*) Extensive application of the standard types of portable cutting machines to ship work is found in their use for trimming the tops of bulkheads (to a metal-to-metal fit for riveting or with a bevel for welding) after the bulkheads are welded at the bottom and at the extremities and are otherwise ready to receive the deck above or the next higher bulkhead section. This operation is performed principally as a combination trim and

bevel cut for welding relatively heavy material. It is obvious that the portable cutting machine must have the track temporarily supported by suitable staging for doing this work.

(*c*) A further use of the standard portable cutting machine is in trimming edges of bulkheads or decks having shape, with or without bevel, following a template or layout line. This is particularly applicable to heavy plate requiring accurate bevel along the edges. If a changing bevel angle is called for, an attachment may be provided for swinging the blowpipe as required to take this into account.

(*d*) The cutting of circular openings on board ship has long been a major problem in many yards. In the shop, of course, this is an extremely simple operation, but an enormous number of holes of varying sizes and in varying thicknesses of material can never be located until the material is in place in ship. Where the quality of the job is not of particular importance, such openings can be cut using a hand blowpipe with a radius rod or other circle cutting attachment, but where accurate work is necessary, this cannot be used. To meet the needs of the yard force, the Welding Section of the Corporation has developed a number of special jigs for cutting openings in inclined surfaces, in any surface where the axis of the opening is not normal to the plane surface, and where it is necessary to cut extremely close to obstructing members. Some of these machines are of a semi-automatic nature; others are fully automatic. Figure 15 shows a hand-operated device for cutting holes, the axes of which are not normal to the surface. As the blowpipe rotates with the revolving of the hand wheel, it is racked up or down as required to maintain constant tip-to-work distance. This device has been successfully used at angles up to 20° from normal to produce oval holes for passage of piping. Figure 16 shows a motor-driven apparatus for cutting true circles, the axes of which are normal to the surface being cut. This device will cut circles up to 14 in. in diameter, thereby covering by far the greater portion of the circular openings encountered in the ships. Figure 17 illustrates a semi-automatic close-quarter circular cutter for cutting openings to within $1^1/_2$ in. of an adjacent bulkhead or deck in either vertical or flat surfaces. The circular rack, upon which the blowpipe is mounted, can be replaced with racks of various radii, by the use of which the scope of operations of the machine can be extended. This apparatus is the most extensively used of the Yard's circle cutting devices due to its ability to function under extremely close conditions of accessibility.

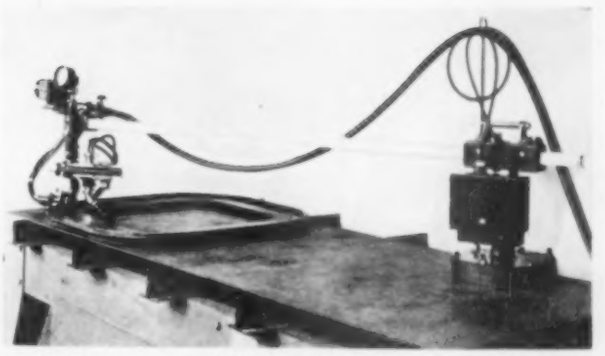
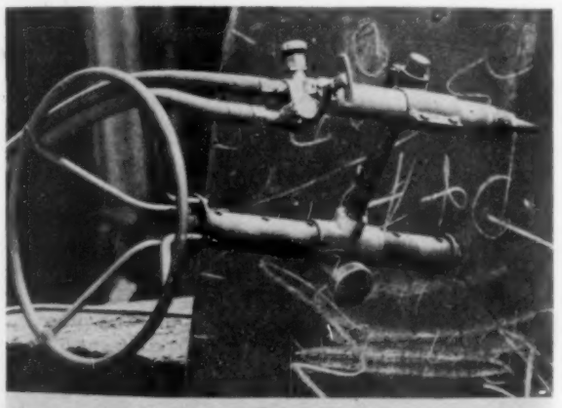


Fig. 18—Equipment for Cutting Openings at any Desired Bevel Angle



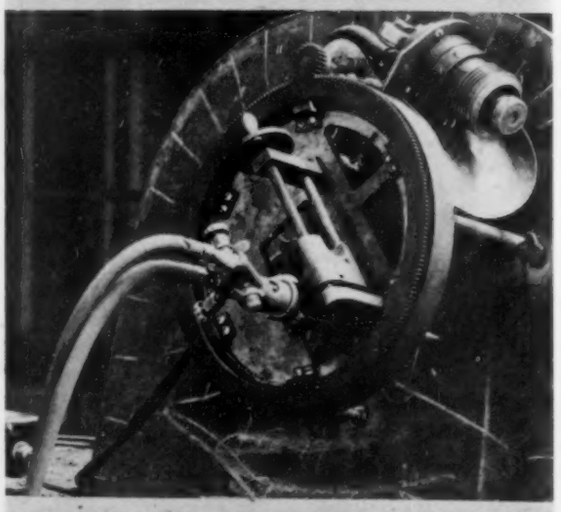


Fig. 15 (Top)—Hand Operated Device for Cutting Holes
Fig. 16 (Center)—Motor Driven Apparatus for Cutting Circles
Fig. 17 (Bottom)—Semi-Automatic Circular Cutter

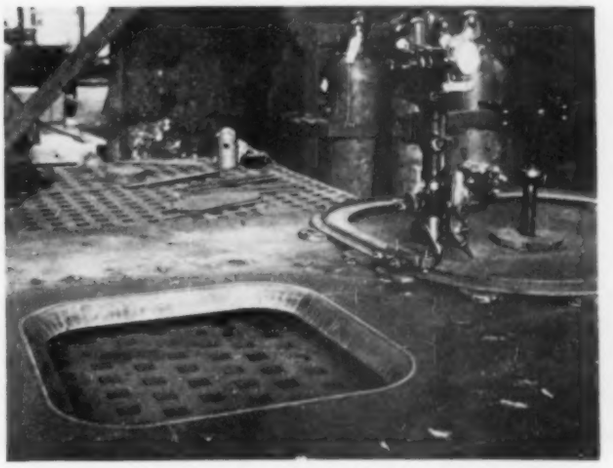
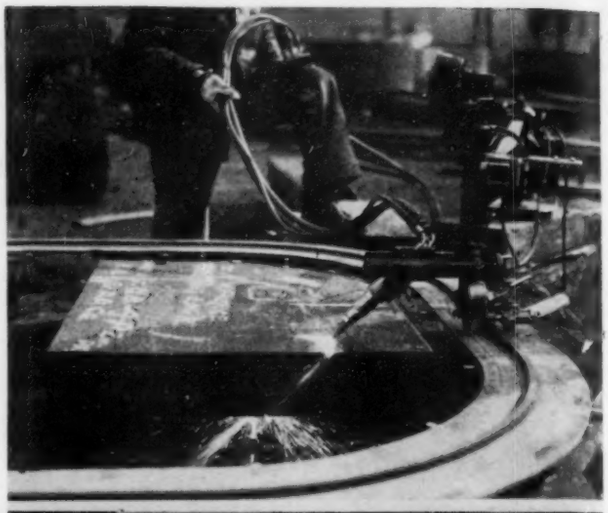


Fig. 19—Cut Made with Above Apparatus

(*e*) One of the most extensive applications of machine flame cutting is in the preparation of beveled openings for manholes, hatches, etc. These are cut with a special template-following machine which requires a template for each size opening to be cut. The economy of making the cut as a continuous operation, with only one set-up being required and a minimum amount of subsequent grinding, if any, being necessary, more than compensates for the cost of the template. New York Ship uses a straight blowpipe inclined at the desired bevel angle and a straight tip, this arrangement being capable of more satisfactory adjustment than the vertical blowpipe and bent tip arrangement used for some time both at this and other yards. With this equipment, openings can be cut at any desired bevel angle and have been cut through material thicknesses, at the kerf, up to 9 in. Figure 18 shows the apparatus for doing this job with the vertical blowpipe and bent tip. Figure 19 shows an experimental cut made with this apparatus. Figure 20 shows the operation of making an experimental corner cut in heavy plate using the straight blowpipe arrangement and Fig. 21 shows the completed experimental cut.

(*f*) Not quite two years ago, in a talk before the New York Section of the AMERICAN WELDING SOCIETY, Mr. H. W. Pierce of this Corporation mentioned the development of a special precision cutting machine for cutting the bottoms of heavy riveted structures to a metal-to-metal fit, taking into account variations in the surface of the material in way of which the structure was to fit. (In connection with this, the definition of "metal-to-metal" fit is actual contact for $^1/_3$ of the length of the joint and the exclusion of a 0.015-in. feeler over the remainder of the joint.) Figure 22 illustrates this apparatus as built. The machine proved to be entirely successful in service and connections over 110 feet long in $1^1/_2$-in. plate have been flame cut with it to meet the above requirements with a minimum of touch-up grinding. Referring to Fig. 22, note that the mounting rig itself is capable of movement in three planes and will therefore take care of variations in the surface contour of the ship structure in all three. In operation, the apparatus crabs against the surface of the plate being cut, side rollers (not shown) holding the tip at a fixed distance from the

Fig. 20—Making Corner Cut



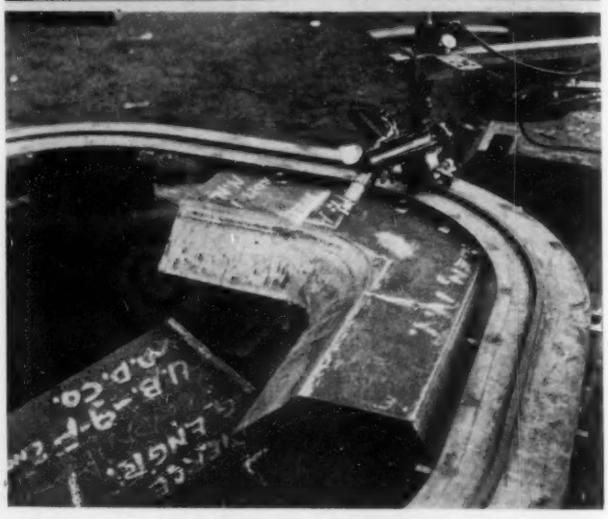


Fig. 21—Corner Cut Completed

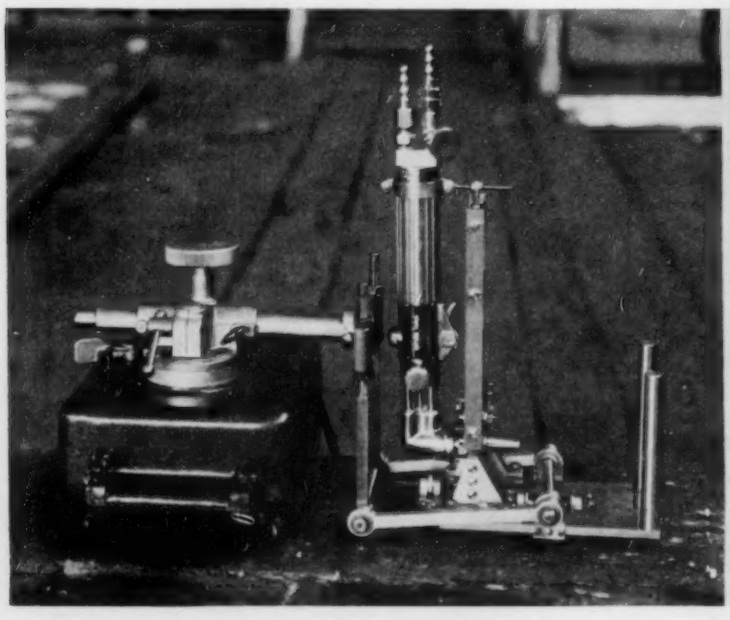


Fig. 22—Precision Cutting Machine

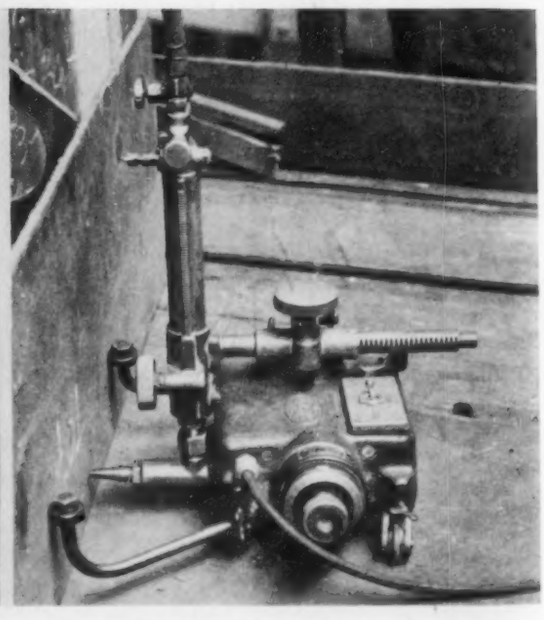


Fig. 23—Standard Machine for Cutting Bevels on Structures

plate surface in all cases. An interesting feature of this machine is that it can be used to cut either from the inside or outside of a cylinder, provided that for cutting from the outside, the diameter of the cylinder cannot be too small. For extremely small diameter cylinders, some auxiliary means of holding the rollers against the plate surface must be provided when cutting from the outside, the crabbing action of the machine not being sufficiently strong to perform this function for diameters less than 30 in. This machine can also be used for cutting bevels on bottoms of structure when a welded connection is required but, since such a high degree of accuracy in cutting is not required in this case, a standard portable cutting machine can be used just as well, using a suitable adaptor or an inclined blowpipe with apparatus similar to that shown by Fig. 23.

The above discussion is intended to present only a brief outline of some of the more important applications of machine flame cutting in a ship construction yard. It is regretted that, due to restrictions upon the dissemination of information, certain very interesting examples cannot be presented and some of the illustrations show nothing more than temporary set-ups on scrap material.

In reference to the present emergency confronting this country, it has often been said, sometimes so vociferously as to react against the industry, that welding is contributing immeasurably to the expediting of national defense construction and fabrication. This is very true, but engineers, fabricators and the interested public should not overlook the fact that flame cutting is practically a twin process to welding and that, to a very outstanding degree, progress in one would not be practicable of achievement without the other. From this angle, it is felt that, in many industries and in the shipbuilding industry particularly, the development of flame-cutting (primarily machine-cutting) processes is of importance comparable to welding and the best talent available should be assigned the task of developing the necessary equipment and special jigs and fixtures necessary to expedite the program to the utmost.

The authors express their appreciation to the members of the staff of the Welding Section, New York Shipbuilding Corporation, for their cooperation in the design and construction of many specialty items, fixtures and jigs, in assembling material, and in editing this paper; and the Reproduction Department of the Corporation for cooperation in the preparation of illustrations.

Current Welding Literature

Airplane manufacture. New Arc Welding Technique for Aircraft Tubing, I. B. Yates. Aero Digest, vol. 39, no. 5 (Nov. 1941), pp. 129–130, 133 and 244.

Boiler Plates, Testing. Fatigue Tests of Structural Steel Faults and Bars Cut from Butt-Welded Boiler Plate, F. C. Lea and J. G. Whitman. Instn. Mech. Engrs.—J. & Proc., vol. 145, no. 5 (Oct. 1941), pp. 228–231.

Brazing Silver Alloys. Best Joint Designs for Silver-Alloy Brazing, F. T. Van Syckel. Steel, vol. 109, no. 23 (Dec. 8, 1941), pp. 97–100 and 117–118.

Bridges, Steel. Welding in Bridge Strengthening, P. B. Bryden. Inst. Welding—Trans., vol. 4, no. 4 (Oct. 1941), pp. 190–197.

Buildings, Steel. All-Welded Steel Frame Building. Eng. & Contract Rec., vol. 54, no. 13 (Mar. 26, 1941), pp. 12–15.

Control, Welding. Graphic Records for Quality Control in Welding, H. Lawrence. Steel, vol. 109, no. 22 (Dec. 1, 1941), pp. 76, 79 and 82.

Electric Welding, Arc. How to Get Most from Arc Welding—IX and X, E. W. P. Smith. Steel, vol. 109, nos. 21 and 25 (Nov. 24, 1941), pp. 66–68 and 70 and (Dec. 22), pp. 75–76 and 82.

Electric Welding, Arc, Structural Steel. Improved Technique in Metal Arc Welding Square Tee Joints in 20–24 S.W.G. Mild Steel Plate, D. M. Kerr. Inst. Welding—Trans., vol. 4, no. 4 (Oct. 1941), pp. 198–200.

Electric Welding Control. Use of Recording Ammeters and Voltmeters in Welding, H. Lawrence. Steel, vol. 109, no. 24 (Dec. 15, 1941), pp. 54, 56 and 59.

Electric Welding Machines. Projection Welding Machine at Right End of Scale. Indus. Power & Fuel Economist, vol. 17, no. 193 (Oct. 1941), p. 132.

Electric Welding Machines. Survey of Spot Welding Plant. Mech. World, vol. 110, nos. 2861, 2862, 2863, 2864 and 2865 (Oct. 31, 1941), pp. 297–299, (Nov. 7), pp. 328–329 (Nov. 14), pp. 388–441 (Nov. 21), pp. 366–369 and (Nov. 28), pp. 288–289 and 390.

Electric Welding, Resistance. Carefully Controlled Electrode Comparison Tests are Profitable, W. J. Brooking. Welding Engr., vol. 26, nos. 10, 11 and 12 (Oct. 1941), pp. 31–34 (Nov.), pp. 27–30 and (Dec.), pp. 24–26.

Gas Plants, War Time. Modern Method of Patching Gasholders, H. H. Hollis. Gas World, vol. 115, no. 2986 (Oct. 25, 1941), pp. 180–181 and 184.

Light Metals. Welding of Light Alloys, E. G. West. Metal Industry (Lond.), vol. 59, nos. 19 and 20 (Nov. 7, 1941), pp. 294–296 and (Nov. 14), pp. 312–313.

Metals Cleaning. Flame Cleaning Ship Structures, J. G. Magrath. Shipbldg. & Shipg. Rec., vol. 58, no. 21 (Nov. 20, 1941), pp. 485–486.

Mines. New Aspects of Welding Utility in Mining Industry, C. W. Brett. S. African Eng., vol. 52, no. 11 (Nov. 1941), pp. 247 and 249.

Mines. Welding Repairs in Collieries, C. H. S. Tupholme. Colliery Eng., vol. 18, no. 213 (Nov. 1941), pp. 259–260.

Motor Truck Manufacture. Assembly Line Technique Used for Producing and Finishing Truck Cabs. Indus. Heating, vol. 8, no. 9 (Sept. 1941), pp. 1001–1002, 1004 and 1013.

Natural Gas Storage, Liquefied. Western Gas Company Erects Unique New Storage Plant. Eng. & Contract Rec., vol. 54, no. 31 (July 30, 1941), pp. 8–10.

Oxyacetylene Cutting. Improving Accuracy of Hand-Cutting Operations. Oxy-Acetylene Tips, vol. 20, no. 12 (Dec. 1941), pp. 269–271.

Oxyacetylene Cutting Machines. Special Worktable for CM-15. Oxy-Acetylene Tips, vol. 20, no. 11 (Nov. 1941), pp. 252–253.

Paper and Pulp Mills. Welding Simplifies Screen Construction, J. Baxter, Jr. Paper Industry & Paper World, vol. 23, no. 9 (Dec. 1941), pp. 896–898.

Petroleum Pipe Lines, California. New Pipe Line to Help Win War. Petroleum World, vol. 38, no. 12 (Dec. 1941), pp. 36–38, 42, 44, 46–47, 50, 52 and 54–56.

Pipes Lines. Recommendations for Oxy-Acetylene Butt Welds in Mild Steel Pressure Pipe Lines. Inst. Welding—Trans., vol. 4, no. 4 (Oct. 1941), pp. 176–180.

Pressure Vessels, Inspection. Experiences in Pressure Vessel Radiographing, A. J. Moses. Industry & Welding, vol. 14, no. 12 (Dec. 1941), pp. 34–35 and 68–69.

Pressure Vessels, Inspection. X-Raying Welded Pressure Vessels, A. J. Moses. Welding Engr., vol. 26, no. 12 (Dec. 1941), pp. 19–23.

Pressure Vessels, Welding. Memorandum on Application of Welding to Pressure Vessels, S. F. Dorey. Inst. Welding—Trans., vol. 4, no. 4 (Oct. 1941), pp. 171–175.

Refrigerators. Resistance Welding and Refrigerator Manufacture. Welding Engr., vol. 26, no. 12 (Dec. 1941), pp. 27–29.

Shipbuilding. All-Welded Deck House Sides, C. M. Leavitt. Mar. Eng. & Shipg. Rev., vol. 46, no. 12 (Dec. 1941), pp. 86–88.

Shipbuilding & Engineering Progress: Review of Twenty-five Years, W. A. Woodeson. Machy. Market, nos. 2141, 2142 and 2143 (Nov. 14, 1941), p. 298 (Nov. 21), p. 304 and (Nov. 28), pp. 310–311.

Skating Rinks. Welding and Ice Skating, H. W. Young. Welding Engr., vol. 26, no. 12 (Dec. 1941), pp. 33–34.

Tools, Hand. How to Safe-End Hammer-Struck Tools. Oxy-Acetylene Tips, vol. 20, no. 11 (Nov. 1941), pp. 245–251.

Welded Steel Structures. Industry Meets All Demands and Develops New Techniques in Structural Steel Fabrication, R. C. Manning. Eng. & Contract Rec., vol. 54, no. 30 (July 23, 1941), pp. 28–30.

Welding. Jointing of Metals by Fusion, A. E. Richards. Metal Industry (Lond.), vol. 59, nos. 22 and 23 (Nov. 8, 1941), pp. 340–343 and (Dec. 5), pp. 361–362.

Welds, Cracking. Crack Sensitivity in Welded Chromium-Molybdenum (1% Chromium, 0.2% Molybdenum) Steels of Thin Section, J. G. Ball. Inst. Welding—Trans., vol. 4, no. 4 (Oct. 1941), pp. 181–187.

The Electrical Characteristics of Resistance Welders and the Proximity Effect of Work Materials*

By J. H. Cooper†

THE daily flow of correspondence and discussions concerning resistance welders indicates that only about 1% of all personnel in contact with such welders fully appreciate the electrical characteristics of the power circuit in the welders involved.

It is at the risk of repeating an old story to this 1%, that the writer prefaces this article with a brief statement of certain fundamentals, before proceeding in detail as to how these fundamentals are applied.

Undoubtedly, the question will arise as to why anyone other than the manufacturer of resistance welding machines should be interested in the electrical characteristics of these welders. While it is true that the operator of a resistance welder may not have or need a greater amount of comparable knowledge of the welder characteristics than an arc welder has of an arc-welding machine, this is not necessarily true in the case of the welding engineer or supervisor. Obtaining the best performance from a resistance welder demands an accurate knowledge of its electrical and mechanical characteristics by the welding engineer or supervisor and in many cases to the extent that the welding engineer must set up rigid specifications concerning these characteristics even before the welder is built.

Welding Capacity vs. Thermal Capacity

The most common misunderstanding arises due to the confusing of thermal capacity with welding capacity, and is usually initiated by a remark similar to the following: "What kva. welder will be required to weld two thicknesses of 16-gage clean low carbon steel?" Such a question is similar to asking: "How many gallons capacity should my automobile gasoline tank have in order to drive at a speed of 50 miles per hour?"

The kva. rating as applied to resistance welders means the following and nothing more: "The welder, if loaded to the kva. rating on the nameplate, will carry that kva. at a 50% duty cycle and not exceed the temperature rise indicated on the nameplate." It should be noted that this has nothing whatever to do with what the machine can weld.

The kva. rating or thermal capacity is influenced by the physical design dimensions, by the electrical characteristics of the iron, electrical conductivity of the copper, method of cooling, etc., and is not changed regardless of what the machine is welding or if it is short-circuited.

The electrical welding capacity, on the other hand, is simply a function of the secondary current which passes through the work. The magnitude of the current, its wave shape and duration of flow influence the welding capacity.

With this fundamental fact in mind, the question in the first paragraph of this section should be rephrased to ask: "How much current will be required to weld two thicknesses of 16-gage clean low carbon steel?" if the point under consideration concerns the weld characteristics only.

If the point under consideration concerns selection of equipment, the question should read, "What kva. rating should a welder have to weld two thicknesses of clean low carbon steel at so many welds per minute, such work requiring welder clearances of so many inches throat depth and so many inches of horn (or platen) clearance?"

In the selection and operation of a given welder, the welding capacity and thermal capacity must be linked together through the medium of required production, such as welds per minute, and the impedance of the welder with the work in place, such impedance being affected by work clearances.

The production can be determined by a time study of the welding cycles, the so-called "floor-to-floor time," which includes loading, welding and unloading.

The impedance of the welder with the work in place is made up of two factors, first, the impedance of the welder alone, and, second, the impedance of the work alone. It is with these two impedance factors that this article mainly deals.

Summarizing, the selection of a welder to do a specific job must treat in order these three factors:

1. How much welding current of a particular wave shape is required to weld the specified job?
2. What is the duty cycle?
3. What is the kva. rating, or thermal capacity of the welder required to produce the current (1) at the duty cycle, (2) such welder having clearances for the geometry of the work (throat depth and horn spacing) and designed according to standard design practices?

Item 1 can be answered through known data or experimental tests.

Item 2 can be calculated through a time study.

Item 3 must be calculated as follows:

(*a*) Determine by calculation or test the welder impedance.

(*b*) Determine by calculation or test the work impedance.

(*c*) Determine by calculation the vectorial sum of (*a*) and (*b*).

(*d*) Determine by calculation the secondary voltage,

* Presented at Annual Meeting, A. W. S., Philadelphia, Pa., Oct. 20 to 24, 1941.

† Welding Engineer, The Taylor Winfield Corp., Warren, Ohio.

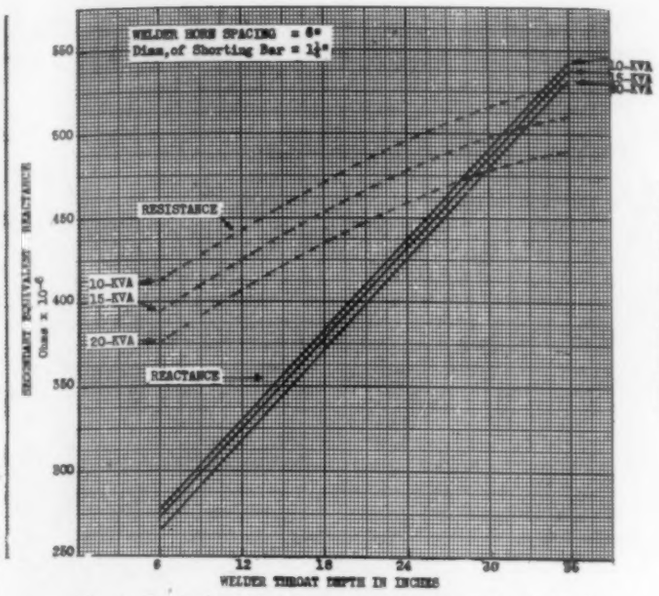


Fig. 1—Equivalent Resistances and Reactions of Standard R. W. M. A. Light Spot Welders

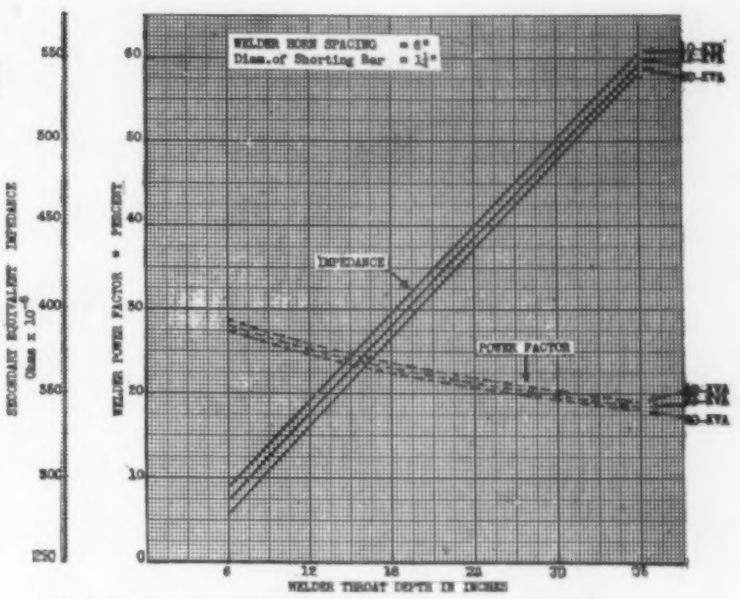

WELDER HORN SPACING = 6"
Diam. of Shorting Bar = 1½"
IMPEDANCE
POWER FACTOR
SECONDARY EQUIVALENT IMPEDANCE Ohms x 10⁻⁶
WELDER POWER FACTOR = PERCENT
WELDER THROAT DEPTH IN INCHES

Fig. 2—Equivalent Impedances and Power Factors of Standard R. W. M. A. Light Spot Welders

by taking the product of the welding current and total impedance in (*c*).

(*e*) Determine by calculation the kva. demand during the weld. This is equal to the product of the welding current and secondary voltage (*d*).

(*f*) Determine the duty cycle in per cent by multiplying the cycles per weld by the number of welds per minute and dividing by 3600 (the number of cycles of 60-cycle frequency per minute).

(*g*) The kva. rating at the standardized duty cycle of 50% then can be calculated through the relationship of:

$$\text{Kva. at } 50\% \text{ d. c.} = \sqrt{\frac{\%\ \text{duty cycle}}{0.707}} \times \text{kva. demand}$$

The specifications for selecting a welder for highest efficiency, instead of being based on the kva. rating, should be based on the "minimum kva. demand when producing a welding current of the required number of amperes." It is not only possible, but often happens, that the power demand to weld with a given current will vary appreciably between welders of the same kva. nameplate rating due to different losses in the welder.

It is erroneous to assume that because one welder has a higher kva. rating than another, the economical procedure is to purchase that welder. It is no more economical to have a welder with a kva. rating or thermal capacity exceeding its welding capacity than it is to pull a baby carriage with a tractor rather than with one manpower.

It is also quite erroneous to select a welder with larger work clearances than needed. To overcome the effect of the excessive secondary inductive loop, the secondary voltage must be raised to produce the same welding current. As the power demand goes up as the square of the secondary voltage, the unnecessary work clearances can be quite expensive. Usually the power factor decreases as the secondary loop or work clearances increase.

It is not always realized that the most efficient welder is one which for a given welding capacity has the lowest power factor. Such a statement is based on having the same work clearances when comparing machines and on the assumption that corrective capacitors are not used. Analyzing the above shows that for a given welding current and inductive loop, the reactive or wattless power demand is fixed. Since the most efficient welder has the lowest power demand and lowest total impedance, and the reactance is fixed, then the resistance is at a minimum. Since power factor is the ratio of resistance to impedance, then the power factor is also at a minimum, and the welder is more efficient. Any effort to raise the power factor by raising the resistance is penalized by higher power demand.

Welder Electric Circuit Variables and Formulas Concerning Impedance

In order to avoid any possibility of misunderstandings as to the nomenclature used in this article, the following definitions and symbols are presented at this time.

Primary voltage	$= V_p$ volts
Primary current	$= I_p$ amperes
Primary wattage	$= W_p$ watts
Total impedance as referred to the primary	$= Z_p$ ohms
Total resistance as referred to the primary	$= R_p$ ohms
Total reactance as referred to the primary	$= X_p$ ohms
Turns ratio	$= TR$
Power factor	$= P.\ F.\ \%$
Secondary voltage	$= V_s$ volts
Secondary current	$= I_s$ amperes
Secondary wattage	$= W_s$ watts
Total impedance as referred to the secondary	$= Z_s$ ohms
Total resistance as referred to the secondary	$= R_s$ ohms
Total reactance as referred to the secondary	$= X_s$ ohms
Max. secondary amperes at rated primary voltage	$= I_{sm}$ amperes
Rated primary voltage	$= V_{pm}$ volts

The symbols in the electric circuit are interrelated as per the following formulas:

$$V_p = I_p Z_p,\ V_s = I_s Z_s \tag{1}$$

$$P.\ F. = \frac{W_p}{V_p I_p} = \frac{W_s}{V_s I_s} = \frac{R_p}{Z_p} = \frac{R_s}{Z_s} \tag{2}$$

$$Z_p = \sqrt{R_p^2 + X_p^2},\ Z_s = \sqrt{R_s^2 + X_s^2} \quad (3)$$

$$R_p = \frac{W_p}{I_p^2} = P.F. \times Z_p \quad (4)$$

$$Z_p = Z_s(TR)^2,\ R_p = R_s(TR)^2,\ X_p = X_s(TR)^2 \quad (5)$$

$$I_{sc} = \frac{V_{pc} \times TR}{Z_p} \quad (6)$$

$$KVA = V_pI_p = V_sI_s \quad (7)$$

$$KW = KVA \times P.F. \quad (8)$$

For reasons of uniformity in comparison, the short circuit impedance measurements of spot and press welders have been defined as being taken under certain standardized conditions, which cover throat depth, horn or platen spacing and type of short circuit.

The values of primary and secondary impedance, reactance, resistance, power factor and maximum secondary amperes, etc., as calculated according to formulas above are taken from readings during short circuit and at a primary voltage sufficient to cause approximately rated primary and secondary currents to flow. For reasons, upon which it is not necessary to elaborate here, these values as calculated are the values of an equivalent circuit where all the power losses and wattless reactive losses are lumped and treated in their respective instances as equivalent losses. All resistances and reactances are lumped as one equivalent resistance and one equivalent reactance. This enormously simplifies the calculations involved and fortunately introduces no appreciable error in the final results.

In order to deal with one common denominator to permit the comparison of various welders without introducing the confusion of various rated primary volt-

Fig. 3—Equivalent Resistances and Reactances of Standard R. W. M. A. Medium Spot Welders

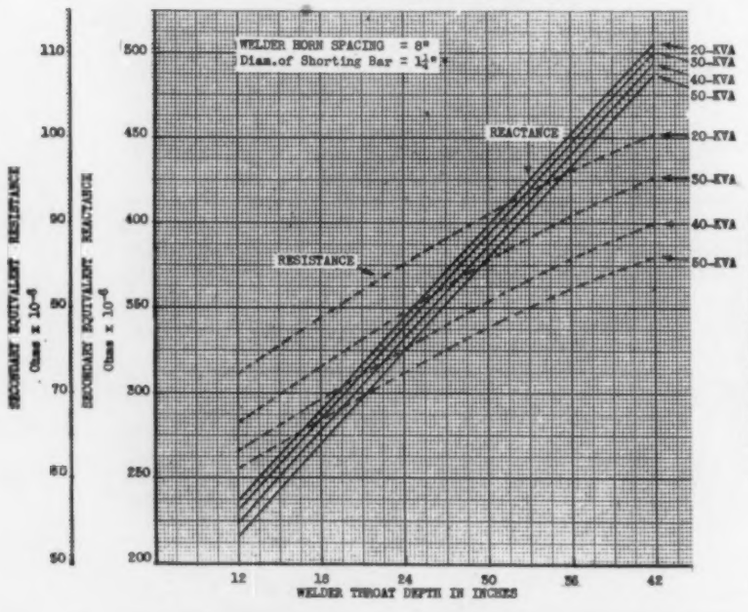


Fig. 4—Equivalent Impedances and Power Factors of Standard R. W. M. A. Medium Spot Welders

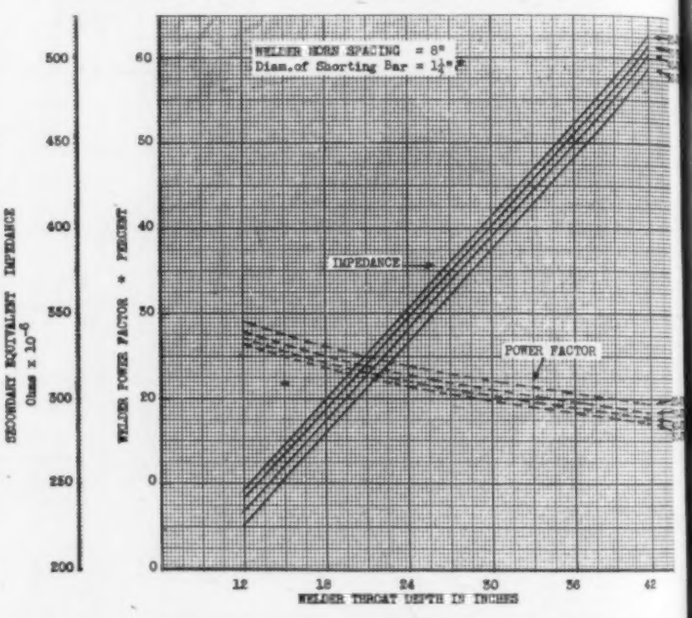

WELDER HORN SPACING = 8"
Diam.of Shorting Bar = 1½"
IMPEDANCE
POWER FACTOR
SECONDARY EQUIVALENT IMPEDANCE Ohms x 10⁻⁶
WELDER POWER FACTOR = PERCENT
WELDER THROAT DEPTH IN INCHES

Fig. 5—Equivalent Resistances and Reactances of Standard R. W. M. A. Heavy Spot Welders

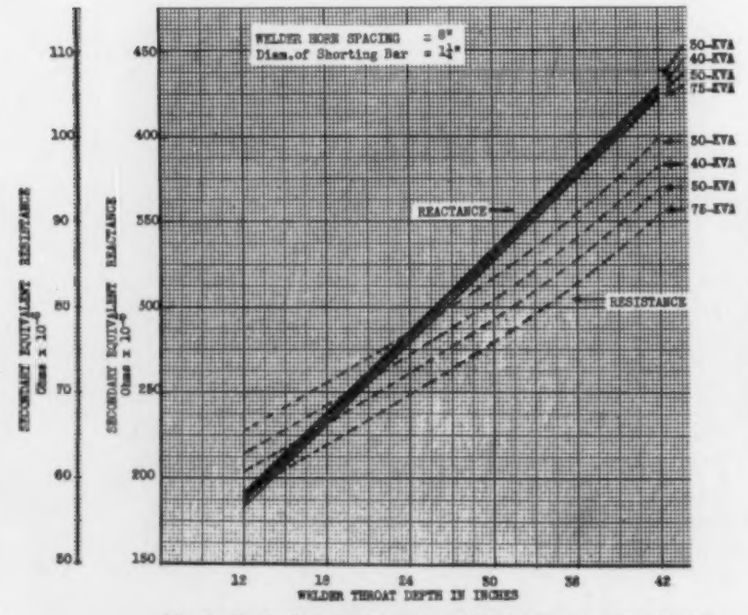
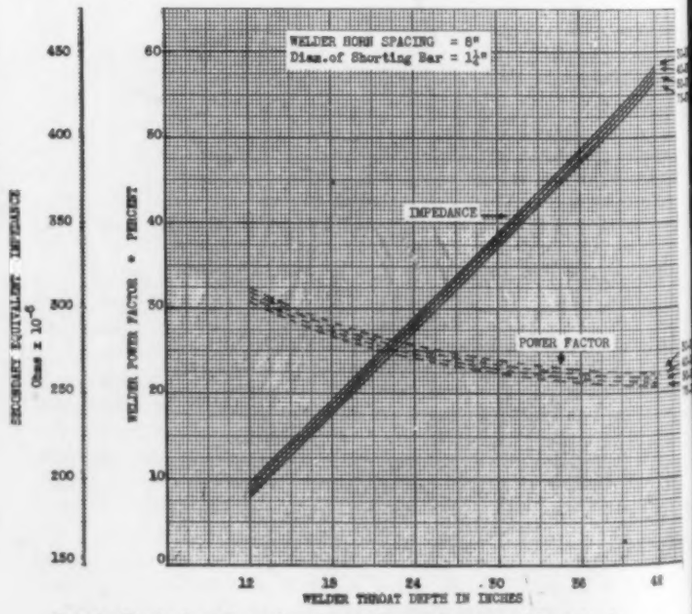


Fig. 6—Equivalent Impedances and Power Factors of Standard R. W. M. A. Heavy Spot Welders


WELDER HORN SPACING = 8"
Diam.of Shorting Bar = 1½"
IMPEDANCE
POWER FACTOR
SECONDARY EQUIVALENT IMPEDANCE Ohms x 10⁻⁶
WELDER POWER FACTOR = PERCENT
WELDER THROAT DEPTH IN INCHES

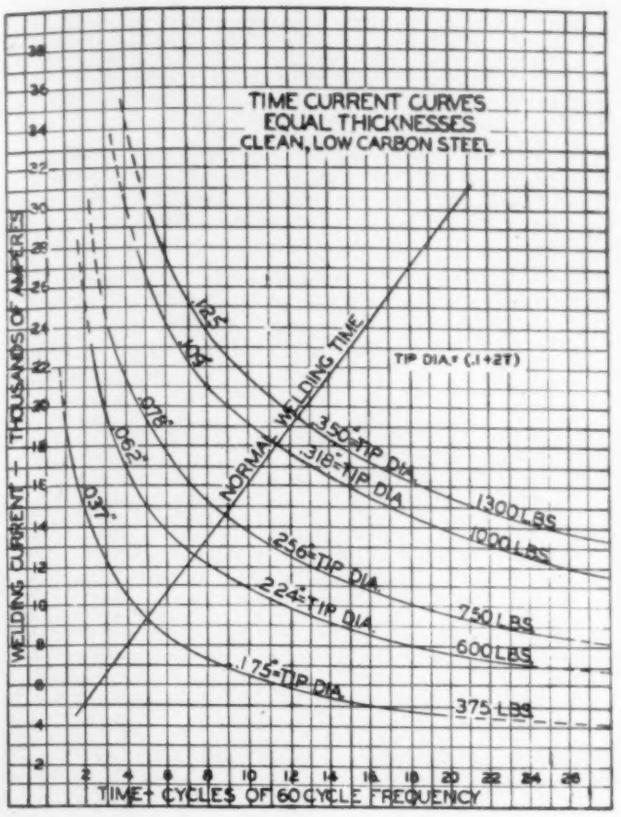


Fig. 7

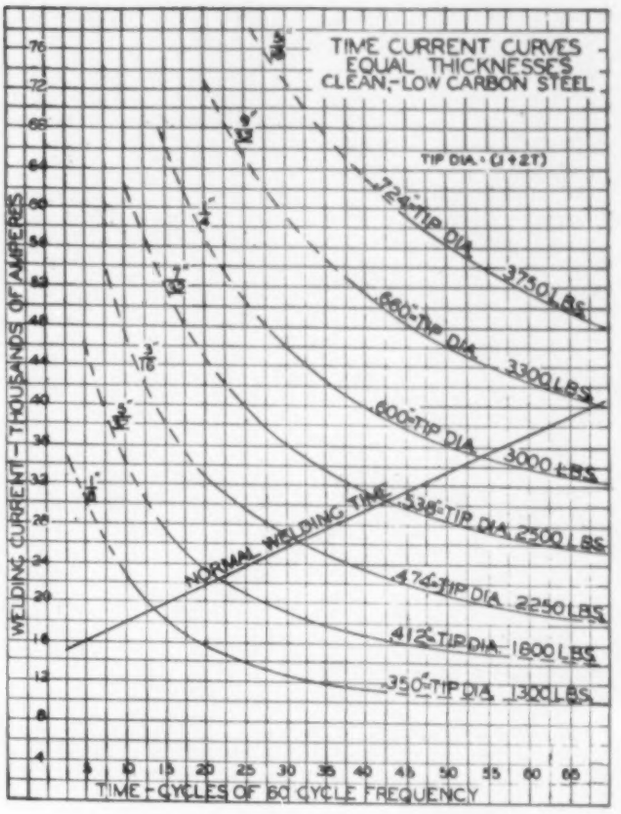

TIME CURRENT CURVES
EQUAL THICKNESSES
CLEAN,-LOW CARBON STEEL
WELDING CURRENT — THOUSANDS OF AMPERES
TIME - CYCLES OF 60 CYCLE FREQUENCY
TIP DIA. = (.1 + 2T)
NORMAL WELDING TIME
.724"-TIP DIA. 3750 LBS.
.660"-TIP DIA. 3300 LBS.
.600"-TIP DIA. 3000 LBS.
.538"-TIP DIA. 2500 LBS.
.474"-TIP DIA. 2250 LBS.
.412"-TIP DIA. 1800 LBS.
.350"-TIP DIA. 1300 LBS.

Fig. 8

ages and turns ratio, secondary equivalent values are used.

All welding or other loads are added to the welder short-circuited secondary resistances and reactances in the same terms and converted to impedances through formula (3). With this total impedance, and a desired welding current known, the required secondary voltage can be calculated through formula (1). The product of this secondary voltage and known secondary current gives the power demand which is to be expected.

Welder and Welder Load Impedances

The equivalent impedance of a welder under load as presented to the primary voltage is made up of three components, the effects of which are all important to the user or purchaser of a resistance welder:

1. The impedance of the welder itself.
2. The impedance caused by magnetic materials in proximity to the secondary circuit.
3. The impedance of the material being welded between the welding tips. This includes contact resistance.

The nature of all three of these components is such as not to lend themselves to precise theoretical calculation, and, therefore, must be worked out empirically. The impedance of the welder itself most nearly lends itself to theoretical calculation, but not precisely so due to skin effect, mutual induction, contact resistance of joints, etc.

Item 1, the equivalent impedance of a welder is best expressed for purposes of comparison in terms of its secondary components, namely, resistance and reactance, R_s and X_s, respectively. This is because the primary voltage and turns ratio which are varied to fit particular applications do not enter into the respective values and so make comparisons more difficult.

Since the resistance and reactance are materially affected by the throat depth and horn spacing, then for purposes of comparison, some definite dimensions must be agreed as standard to permit accurate comparisons to be made.

If the measurements on spot welders are made with just the small welding area of the electrodes in contact, inconsistent results will be obtained due to the low measuring voltage and variable contact resistance. For this reason, a standard method of short circuiting must be defined. In the case of spot welders, the usual method is to replace the electrode holders with a solid copper bar of the same cross section as the electrode holders. The secondary current-carrying arms are agreed to be spaced 6 inches for light spot welders and 8 inches for medium spot welders.

A source of low test voltage is then applied to the primary terminals, the value of the voltage being such as to cause rated nameplate current to flow. These currents, voltages, and watts are measured for all transformers under test and the equivalent secondary resistances and reactances calculated as in formulas (1) to (5), inclusive.

Figure 1 indicates the variation of resistance and reactance of standard R. W. M. A. light spot welders, 10 to 20 kva., inclusive, these values being calculated from measurements taken under above standard conditions.

Figure 2 indicates the variation of impedance and power factor of the same welders.

Figure 3 shows values comparable to Fig. 1 for resistance and reactance of standard R. W. M. A. medium size spot welders, 20 to 50 kva., inclusive, while Fig. 4

shows the impedance and power factor variations for these same 20- to 50-kva. welders.

Figures 5 and 6 show the resistance, reactance, impedance and power factor values for the standard R. W. M. A. heavy spot welders, 30 to 75 kva., inclusive.

All of these values are averaged from tests made on hundreds of production welders over a period of years and are precise values. It will be noticed that for any one of the three sizes of welders, i.e., light, medium or heavy, the power factors and impedances are essentially the same for all kva. welders in that group. This is to be expected as the design of any group is such that essentially the same secondary copper sections are used throughout the group. The primary windings change with the primary power supply voltage, kva. rating, and required secondary voltage, but affect the equivalent secondary values of resistance and reactance very little. Consequently, the power factor and impedance variation versus kva. is almost negligible in any one group.

Specifications to be set up for determining spot welders' electrical performance to be exact should include the following provisions:

1. Type of welder.
2. Primary voltage, frequency of power supply.
3. Kva. rating at 50% duty cycle.
4. Secondary equivalent resistance.
5. Secondary equivalent reactance.
6. Desired secondary amperes.
7. Statement that above values of resistance, reactance and current are to be measured under standardized conditions of horn spacing, short circuit means and the required throat depth.

A specific example would be: A medium size spot welder with a 24-inch throat depth, wound for 440 volts, 60-cycle power supply, having a 40-kva. rating at 50% duty cycle, such welder to have not more than 330×10^{-6} ohms equivalent secondary reactance, and not more than 75×10^{-6} ohms equivalent secondary resistance and to deliver 22,000 secondary amperes under conditions of standard horn spacing and short circuit.

The omission of the provisions of a specified maximum resistance and reactance leaves the way open for the entrance of an inefficient design of welder, which may greatly and unnecessarily increase the kva. power demand and lower the maximum operating duty cycle, and consequently decrease the number of welds per minute which can be made.

Having gone through the preceding reasoning and calculations to both define the actual values of the circuit constants and show how they may be used to lay down specifications for the welder itself, a common reaction will be that "perhaps this is all right, but how about picking a welder to do a given job."

The procedure to do this is to first determine by experiment or otherwise the required welding current through the work.

In the case of clean low carbon steel, the data recorded by the curves in Figs. 7 and 8 may be used with satisfactory accuracy. If there is no particular reason to dictate otherwise, use the welding current at the point where the "normal welding time" line crosses the time-current curve for the steel thickness under consideration.

Then refer to the curves on the proper figure of Fig. 1, 3 or 5, which indicates the type of welder, the kva. rating and throat depth desired.

From this curve, pick off the values of resistance and reactance for that throat depth and kva. rating.

To these values add the values of resistance and reactance determined from Fig. 9, of the amount of steel in the throat in proximity to the secondary circuit.

Also add the values of resistance determined from Fig. 10, of the series resistance of the work between the electrodes.

The sum of these respective resistances and the sum of the reactances may be converted to an impedance, Z_s, by the use of the previously indicated formula (3). The product of this impedance, Z_s, and the welding current as determined from Figs. 7 and 8 will give the necessary secondary voltage. The product of this voltage and the welding current will give the power demand per weld.

Referring to the formula that kva. at 50% d. c. = $\frac{\sqrt{\%\,\text{Duty Cycle}}}{0.707} \times \text{Kva.}$ demand and knowing both the kva. rating and kva. demand, the maximum duty cycle can be figured. With this maximum duty cycle and the known time per weld as determined by Figs. 7 and 8, the maximum number of welds can be calculated. If this is not great enough, the calculations must be repeated using a higher kva. rated welder as shown on Fig. 1, 3 or 5.

An example of the above is given:

Suppose we desire to weld two pieces of $^1/_8$-inch steel with a 30-inch throat welder of 75-kva. rating, what

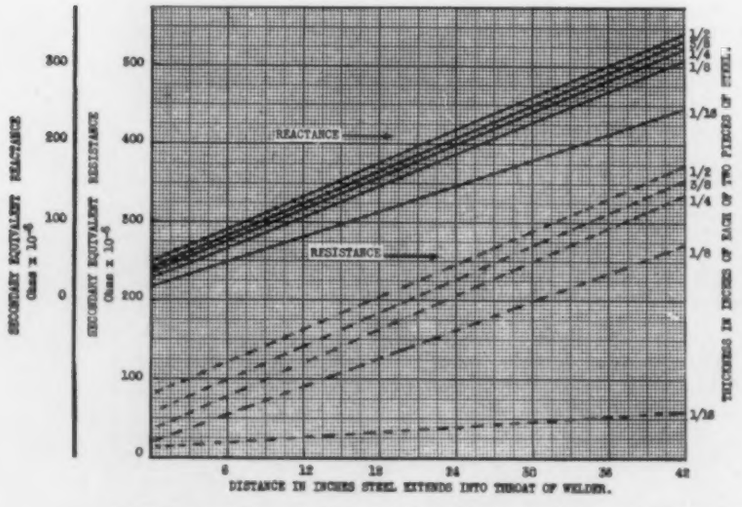


Fig. 9—Equivalent Resistances and Reactances of Steel in Throat of Welder Only, Equally Spaced Between Horns and 18 In. Wide

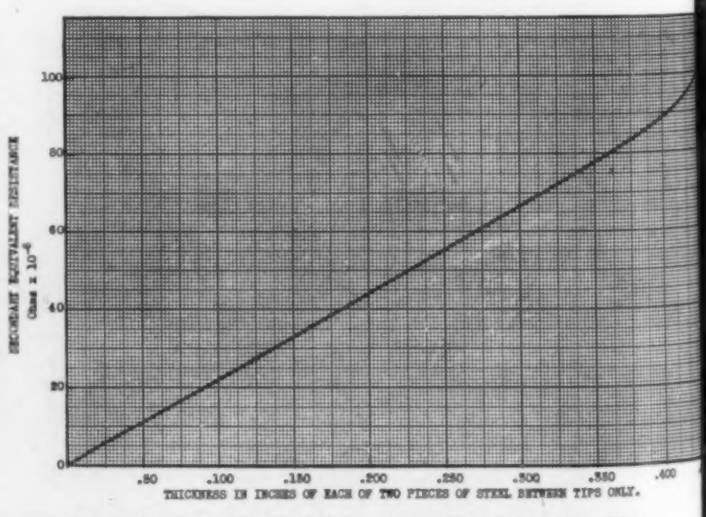


Fig. 10—Equivalent Series Resistance of Steel Between Welding Tips and None in Welder Throat

current is needed, what will be the power demand and what are the maximum number of welds obtainable?

1. From Fig. 7, 2 pcs. 1/8-inch steel require 19,500 amperes and 13 cycles.
2. From Fig. 5, the resistance is 76×10^{-6} ohms, and the reactance 327×10^{-6} ohms.
3. From Fig. 9, the resistance is 200×10^{-6} ohms, and the reactance is 230×10^{-6} ohms, due to the proximity of the steel in the throat to the secondary conductors.
4. From Fig. 10, the resistance in series between the tips is 26×10^{-6} ohms.
5. The sum of the resistances is 302×10^{-6} ohms and the sum of the reactances is 557×10^{-6} ohms. By formula (3), $Z_s = 642 \times 10^{-6}$ ohms.
6. Welding current, 19,500 amps. multiplied by 642×10^{-6} ohms = 12.5 secondary volts.
7. Kva. demand = 19,500 amps. multiplied by 12.5 secondary volts = 244 kva.
8. If $\sqrt{\%\ \text{Duty Cycle}} = \frac{75}{244} \times 0.707$, then the maximum per cent duty cycle = 4.7%.
9. 4.7% × 3600 (cycles per min.) = 169 cycles maximum, which at 13 cycles per weld equals a maximum of 13 welds per minute.
10. The load power factor by formula (2) is $\frac{302 \times 10^{-6}}{642 \times 10^{-6}} = 47\%$.

The above calculations tell all that is needed to be known about the electrical characteristics of a spot welder to purchase a welder, or put into production a welder of these known characteristics.

The welding machines manufactured in accordance with standards adopted by the Resistance Welding Manufacturers' Association in recent years carry the following data on their nameplates:

1. Type of welder including primary voltage and frequency, and throat depth.
2. Thermal rating as indicated by the kva. values at 50% duty cycle, specified temperature rise, and pressure and temperature of cooling water.
3. Welder electrical characteristics as indicated by maximum and minimum short-circuited current under standard short-circuited conditions.

To obtain the secondary equivalent impedance at maximum secondary voltage from this data, divide the nameplate maximum secondary voltage by the nameplate maximum secondary current.

To obtain the maximum power demand which under short-circuited conditions produces the nameplate short-circuited current, multiply the maximum secondary voltage by the stated short-circuited current. A comparison between welders which indicates the lowest power demand to obtain the same short circuit current is a direct measure of the comparative efficiency of the welders.

The turns ratio may be obtained by dividing the rated primary voltage by the secondary voltage and then the formulas previously given may be used.

The only information which cannot yet be obtained from the nameplate values is the power factor which permits dividing the impedances into the components of resistance and reactance. The standards may soon be revised to include this necessary information.

As stated before, the values of equivalent resistance and reactance shown by Figs. 1 to 6, inclusive, are precise values for standardized welders and are compiled from tests of hundreds of welders.

At the time of starting this investigation, it was believed that the values of curves in Figs. 9 and 10 would also be precisely determined by the time of presenting this paper. Circumstances have prevented carrying the investigation to a precise conclusion and the curves are made up of data tabulated from impedance measurements made with relatively low measuring current values and with ordinary volt, ampere and watt meters. The values of current used were such that during the relatively long time necessary to read the meters, the work and welding points did not overheat.

Certain factors indicate that when measuring at these current values, the magnetic material in proximity to the secondary conductors has not reached the saturation point and so introduces a certain degree of error.

It is entirely possible that further investigation will show that practically all welding is done under circumstances which saturate the magnetic materials and that as the welder throat is loaded with varying amounts of the material, a definite value of secondary voltage must be added as more material is introduced. If this is found to be true, the added secondary voltage will vary only as to the amount of material and not have a secondary variation due to the degree of saturation.

Measurements of variables during such a further investigation must be done with an oscillograph due to the short times involved using the necessary high currents.

The values of Figs. 9 and 10 are at least on the high side and can be used conservatively as an approximation of the precise values.

CALENDAR OF EVENTS

Society and Section Meetings

(For further details see Section Activities)

PHILADELPHIA SECTION—February 16, 1942.

FIFTH LECTURE NEW YORK SECTION LECTURE COURSE—February 17, 1942.

NORTHERN NEW JERSEY—February 17, 1942.

LOS ANGELES SECTION—February 19, 1942.

MARYLAND SECTION—February 20, 1942.

SIXTH LECTURE NEW YORK SECTION LECTURE COURSE—February 24, 1942.

DETROIT SECTION—March 2, 1942.

PEORIA SECTION—March 4, 1942.

OKLAHOMA CITY SECTION—March 5, 1942.

BOSTON SECTION—March 6, 1942.

COLUMBUS SECTION—March 13, 1942.

ST. LOUIS SECTION—March 13,1942.

PHILADELPHIA SECTION—March 16 1942.

NORTHERN NEW JERSEY—March 17, 1942.

LOS ANGELES SECTION—March 19, 1942.

NORTHWEST SECTION—March 19, 1942.

MARYLAND SECTION—March 20, 1942.

Meetings of Other Societies

AMERICAN PHYSICAL SOCIETY. 247th meeting, February 20–21, 1942, Detroit, Mich.

SOUTHERN SAFETY CONFERENCE. February 22–24, Roosevelt Hotel, New Orleans, La.

AMERICAN SOCIETY FOR TESTING MATERIALS. Spring meeting, March 2–6, 1942, Cleveland, O.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Spring meeting, March 23–25, 1942, Houston, Tex.

FIRST WESTERN HEMISPHERE FOUNDRY CONGRESS FOUNDRY AND ALLIED INDUSTRIES SHOW, 46th Annual Convention, April 20–24, 1942.

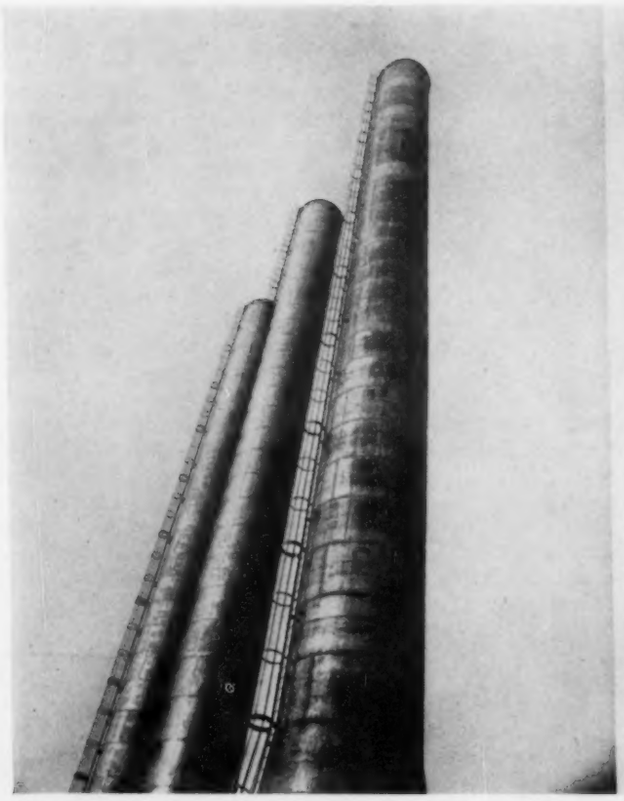


Fig. 1—The World's Largest Welded Steel Stack Looms in the Foreground of This Photograph. The Contractors on This Job Turned to Arc Welding to Save Material

Fig. 2—Tapered Base of the Welded Stack. The Base Ring Is Almost 21 Ft. Across at the Bottom

World's Tallest Arc-Welded Stack Completed in West Virginia

By A. F. Davis*

ERECTION of what is believed to be the tallest welded steel stack in the world recently was completed at Alloy, West Va., by the General American Transportation Corp. of Sharon, Pa.

The concern turned to arc welding in construction of the third of three stacks erected for the Electro Metallurgical Co. to effect a savings in material. Between 5% and 6% was saved in the laps.

The welded stack, shown in the foreground in Fig. 1, is 200 ft. high and stands with the other two on a power plant building 90 ft. high.

A view of the tapered base of the welded stack is shown in Fig. 2. The bottom ring is $^3/_4$ in. thick and 20 ft. 10 in. wide at the base. The rings from the second to the eighth are of $^1/_2$-in. material. The ring at the extreme top of the stack is of material $^1/_4$ in. thick and is 12 ft. 11 in. in diameter. All are made of Corten steel. Figure 3 shows the welded stack nearing completion. A derrick may be seen at the top of this stack, where workmen are putting on the finishing touches to the tall structure.

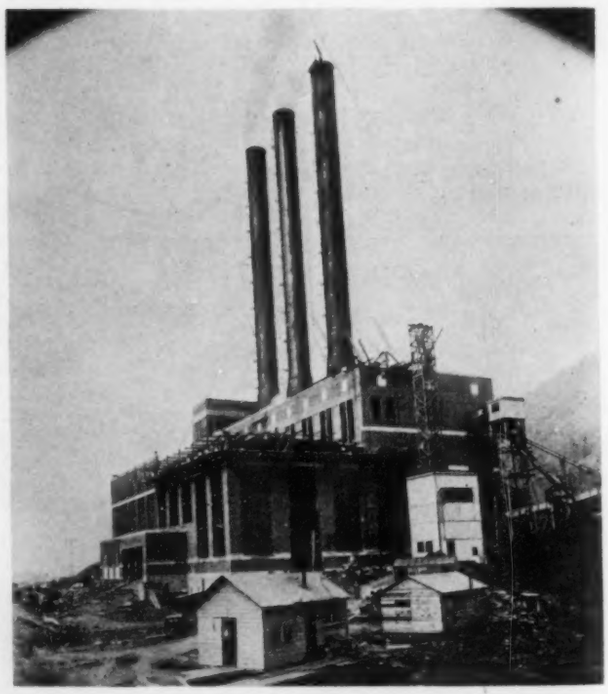
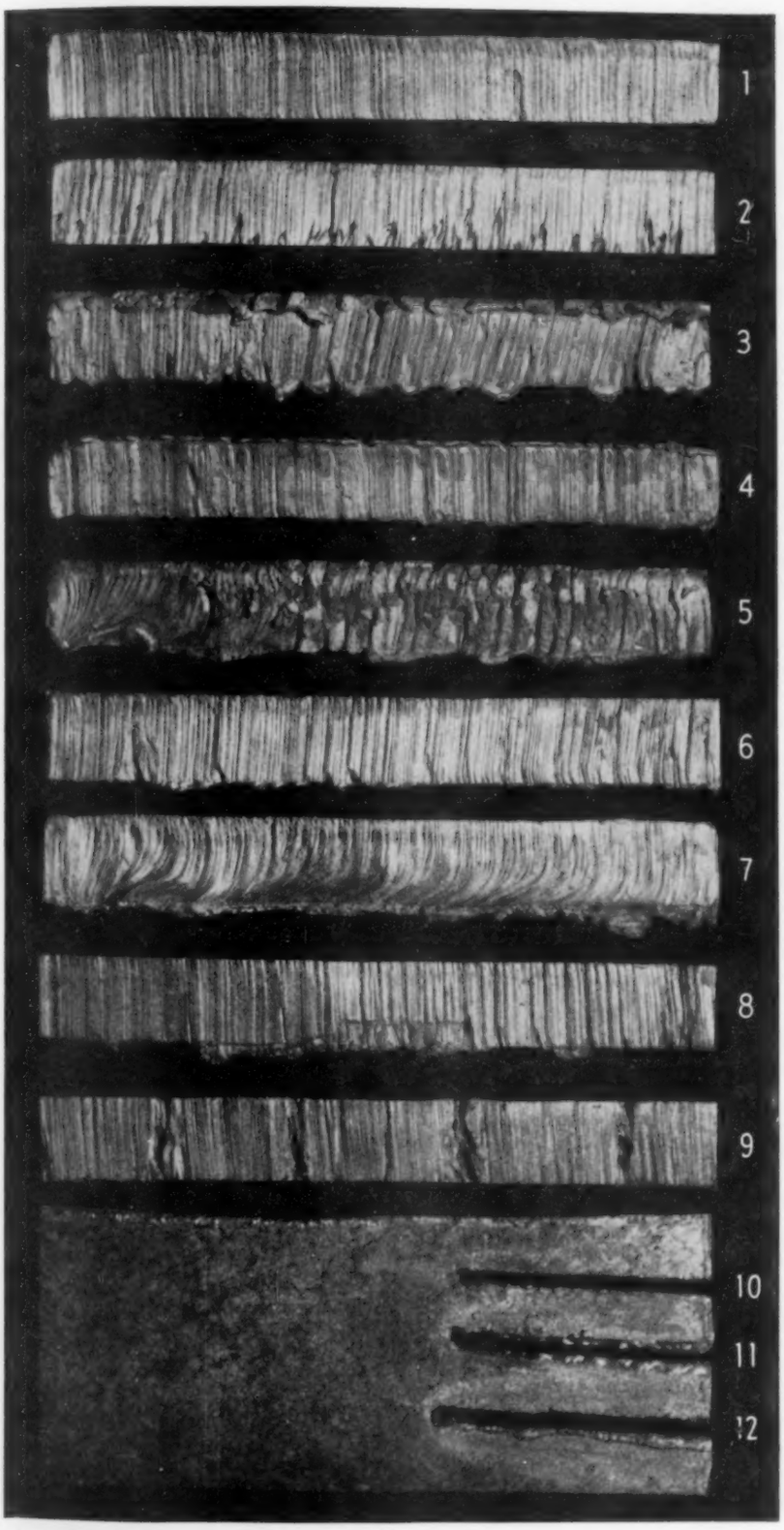


Fig. 3—The Welded Stack, 200 Ft. High, Nears Completion

* Vice-President, The Lincoln Electric Co., Cleveland, Ohio.

Correct Procedures vs. Common Faults in Hand-Cutting

By H. H. Moss*



(1) Correct Procedure

Compare this correctly made cut in 1-in. plate with those shown below. The edge is square and the drag lines are vertical and not too pronounced.

(2) Preheat Flames Too Small

Fault: preheat flames too small—only about 1/8 in. long. Result: cutting speed was too slow, causing bad gouging effect at bottom.

(3) Preheat Flames Too Long

Fault: preheat flames too long—about 1/2 in. Result: top surface has melted over, the cut edge is irregular, and there is too much adhering slag.

(4) Oxygen Pressure Too Low

Fault: oxygen pressure too low. Result: top edge has melted over because of too slow cutting speed.

(5) Oxygen Pressure Too High

Fault: oxygen pressure too high and nozzle size too small. Result: entire control of the cut has been lost.

(6) Cutting Speed Too Slow

Fault: cutting speed too slow. Result: irregularities of drag lines are emphasized.

(7) Cutting Speed Too High

Fault: cutting speed too high. Result: there is a pronounced rake to the drag lines and the cut edge is irregular.

(8) Blowpipe Travel Unsteady

Fault: blowpipe travel unsteady. Result: the cut edge is wavy and irregular.

(9) Lost Cut Not Properly Restarted

Fault: cut lost and not carefully restarted. Result: bad gouges were caused where cut was restarted.

(10) Good Kerf

Compare this view (from the top of the plate) of a good kerf with those below. This cut was made by using correct procedures.

(11) Too Much Preheat

Fault: too much preheat and nozzle too close to plate. Result: bad melting over the top edge occurred.

(12) Too Little Preheat

Fault: too little preheat and flames too far from plate. Result: heat spread has opened up kerf at top. Kerf is too wide and is tapered.

* The Linde Air Products Co., New York, N. Y.

THE AMERICAN WELDING SOCIETY

ACTIVITIES — RELATED EVENTS

NOMINATING COMMITTEE

With the approval of the Executive Committee the President has appointed the following members to constitute the 1941–42 Nominating Committee:

J. H. Deppeler, Chairman, Metal & Thermit Corporation, New York, N. Y.

E. A. Doyle, The Linde Air Products Co., New York, N. Y.

A. J. Moses, Combustion Engineering Co., Chattanooga, Tenn.

L. W. Delhi, Western Pipe & Steel Co., San Francisco, Calif.

D. H. Corey, The Detroit Edison Co., Detroit, Mich.

J. W. Meadowcroft, E. G. Budd Mfg. Co., Philadelphia, Pa.

S. L. Rich, Bell Aircraft Corp., Buffalo, N. Y.

The By-Laws require that these names be published in the JOURNAL on or before March 1st. The Committee is required to deliver to the Secretary in writing on or before the last Tuesday in May, the names of its nominees for the various elected officers next falling vacant, together with the written acceptance of each nominee.

The purpose of publishing the names of the Nominating Committee in the JOURNAL is to provide every member with an opportunity to make suggestions to the Nominating Committee. To be effective, it is essential that these suggestions be sent in at once as, naturally, the Nominating Committee will be required to hold early meetings in order to fulfill its duties as required by the By-Laws.

The offices to be filled are: President, First Vice-President, Second Vice-President, and four directors. The present incumbents in the offices of President, First Vice-President and Second Vice-President are ineligible to re-election in the same office.

The Directors-at-Large are selected by the Nominating Committee, with due consideration to geographic distribution.

THE PRESIDENT'S MESSAGE

War economy is beginning to affect the lives of individuals and will, as the war progresses, exert a profound influence upon our habits and standards of living. It is to be expected that our technical societies will also feel the pressure of war economy.

One of the early reactions during war is the suppression of technical information first, because of the lack of time available for the preparation of articles and second, because of the feeling that the publication of technical information is of assistance to the enemy. Of course, many will fail to prepare articles for publication due to the pressure of current work but it is to be hoped that our war literature will remain as rich and instructive as has been the technical literature of recent decades. With the expansion of production and the incident training of so many technical men in new fields, there is a greater need for the dissemination of information and the stimulation of thinking of our engineers.

There is, of course, information which must be withheld as, if divulged, it would react to our military disadvantage. There is a tendency to include a great deal of technical information in this category. The classification should be made by individuals who have an appreciation of relative developments both here and abroad. A lack of understanding can readily lead to an overestimation of our technical advancement and an underestimation of developments elsewhere. The concealing of any information except that essential to protect military secrets will react more harmfully to ourselves than complete publication can furnish assistance to the enemy. Our strength lies in our industrial capacity, our organizing ability and the spirit of cooperation which exists in our industries. We have no superior brains and no monopoly on fundamental knowledge. It is unreasonable to expect that any one country is going to make remarkable discoveries greatly in advance of others. It is reasonable to expect that, under the necessity of events one nation may develop war products in advance of another. The national genius may have been diverted to that field. Ours has been utilized for the products of peace. To make up for this lost time we need first to advance to the level of development abroad before we can expect to outstrip it.

Military engineering has been little publicized in this country. Engineers and scientists have been occupied in other fields. Our technical personnel must now be concentrated on military problems, applying all the developments of our industrial advancements. If the optimum is to be achieved, both the conditions that exist and our needs must be frankly stated and our problems outlined in order that coordinated efforts may be devoted to their solution. Contributions to our technical development may come from many sources but intelligent contributions can be made only by those having a knowledge of past experience and current needs.

These thoughts lead to the conclusion that our technical organizations should adopt a broad, far-sighted attitude, stimulate technical discussions and publications and foster and encourage that which may lead to a better understanding of our problems. Only in this manner can the application of fundamental knowledge to new inventions and the better utilization of existing ones be speeded up to meet our war requirements.

Only through services such as these can our technical societies survive a war economy.

ANNUAL MEETING

Very shortly the Program Committee will begin to hold meetings to develop a program for the Annual Meeting to be held in Detroit during the week of October 10th.

All members who wish to present papers at this meeting are urged to notify the Secretary of the Committee promptly, giving title and a sentence or two descriptive of what the paper will contain. These suggestions should be addressed to W. Spraragen, Secretary, Program Committee, American Welding Society, 33 West 39th Street, New York.

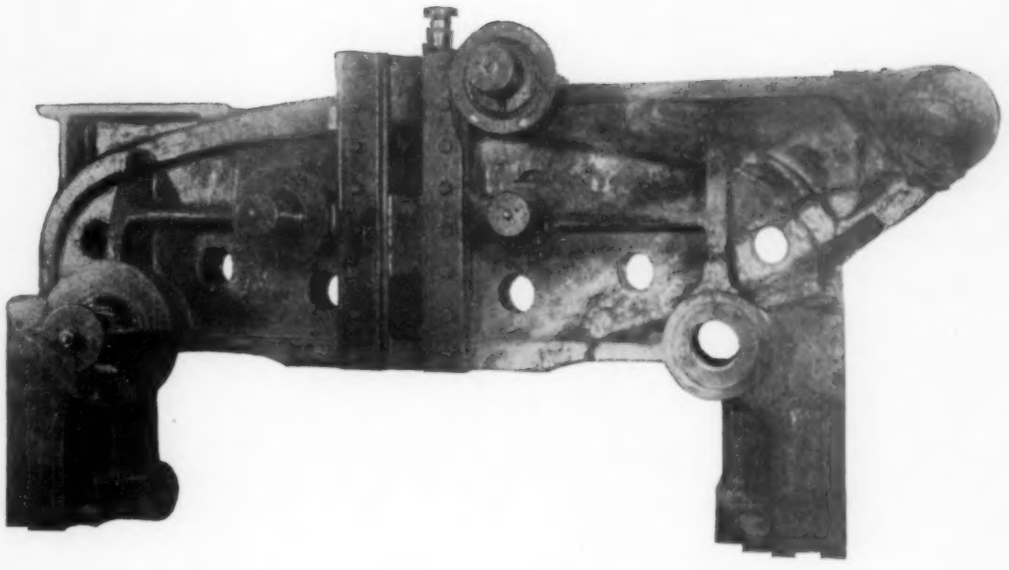
MEMBERSHIP ACTIVITIES

The Northern New York Section easily takes the lead for the month of December in bringing in 27 new members. Of these, however, 26 were in the Operating Class; the other was an Associate Member. Northern New Jersey is a good second by bringing in 1 Member, 6 Associate Members and 9 Operating Members. Third on the list is the New York Section with 2 Members, 2 Associate Members and 8 Operating Members. In a way, Milwaukee set the record as it brought in the highest number of Members for the month—6.

COURSE IN WELDING METALLURGY AT M. I. T.

In addition to the existing course in Welding Engineering directed by Prof. P. E. Kyle an elective course in welding metallurgy has been offered this year to the students by the Department of Metallurgy M. I. T., Cambridge, Mass. A fairly large attendance of more than twenty senior and graduate students has registered for the new course, and this alone may be regarded as an ample justification for selecting this new subject and a good evidence of the increasing interest in welding.

The course, which is given by Dr. D.



BACK IN ACTION...TRIPLE ACTION...

because of speedy, reliable Tobin Bronze Welding

INCALCULABLE sums are saved for industry every year in both equipment and time by repair welding with Tobin Bronze—the original low melting-point (1625°F) bronze welding rod.

Take, for example, this badly fractured 15-ton triple action press crown that was disabled when a break occurred in the two webs above the right hand cross shaft bearing. This production giant was needed vitally... and it was back on the job in a week—thanks to the Super Arc Welding Company of Detroit and 1150 lbs. of Tobin Bronze.

A feature of this repair was the fact that the completed weld required no machining. After tack welding, bearings were checked for alignment... and constant checking was maintained during the entire welding operation.

For information on welding with Tobin Bronze* and other Anaconda Rods, ask us to send our Publication B-13. You'll find its data doubly useful at this time when speed is the watchword.

4294

*Tobin Bronze is a trade-mark of The American Brass Company registered in the U. S. Patent Office.

ANACONDA from mine to consumer

Anaconda Welding Rods

THE AMERICAN BRASS COMPANY—GENERAL OFFICES: WATERBURY, CONNECTICUT

In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ontario • *Subsidiary of Anaconda Copper Mining Company*

Rosenthal known to our readers for his contributions to the study of heat flow and weldability of carbon steels, deals with the various metallurgical processes involved in welding and attempts to bring them in close relationship with the heat distribution during welding.

BRITISH WELDING AUTHORITY STUDIES U. S. PRACTICES

George F. Clipsham, managing director of the British subsidiary of The Lincoln Electric Company, Cleveland, who is in this country to study the newest developments in welded ships and tanks, addressed the Cleveland Section of the AMERICAN WELDING SOCIETY recently on his observations of the Battle of Britain and the war in the Atlantic.

He told WELDING SOCIETY members that welding is being used widely in the manufacture of British armaments and endorsed the recently announced plans of the U. S. War Department to change from riveted to welded tanks.

The British industrialist described his latest trip across the Atlantic. He traveled in a Norwegian vessel which was forced to drop out of its convoy in a storm and travel at reduced speed after the main engine crankshaft was broken.

Clipsham and his fellow passengers were required to wear life preservers to which electric lamps were attached. They also were provided with whistles similar to those used by policemen. These two signaling devices have aided in the rescue of many passengers of torpedoed ships, according to Clipsham.

"The Allies now have a great advantage in the battle of the Atlantic," he said. "This is because of the effectiveness of the combined American and British patrol systems and the loss of many of the experienced Nazi submarine captains."

Clipsham, a native of Liverpool, England, is a naturalized U. S. citizen.

EXECUTIVE COMMITTEE MEETING AMERICAN WELDING SOCIETY

A meeting of the Executive Committee was held on December 11, 1941, in the Engineering Societies Building, New York. Present were: C. A. Adams, David Arnott, A. B. Bagsar, A. G. Bissell, H. C. Boardman, E. V. David, J. H. Deppeler, E. R. Fish, O. B. J. Fraser, D. S. Jacobus, H. S. Smith, W. Spraragen, M. M. Kelly.

Standing Committee Personnel Changes

The following changes in committee personnel were approved:

Membership Committee.—Addition: A. L. Pfeil as Member-at-large.

Program Committee.—Drop E. F. Kelley, declined to serve; R. H. Aborn, declined to serve.

Code of Principles of Conduct.—A. E. Gibson, *Chairman*, in place of H. S. Smith.

Educational Committee.—Substitution: J. R. Stitt in place of C. E. MacQuigg.

Public Relations Committee.—Appointment: H. S. Smith, *Chairman;* H. F. Reinhard, *Secretary;* J. I. Banash, J. H. Deppeler, C. I. MacGuffie, A. F. Davis, L. W. Delhi, J. O. Jackson, D. S. Jacobus, A. M. Meyers, E. C. Smith.

Manufacturers Committee.—Addition: M. H. Rutishauser.

Section Exhibits

It was voted to approve the Section Officers' recommendations that a policy be established requiring Sections of the AMERICAN WELDING SOCIETY to obtain approval of the Board of Directors or Executive Committee of the SOCIETY before putting on exhibits.

It was voted that Section Officers be advised that it is the opinion of the Executive Committee of the SOCIETY that no attempt should be made by the Sections during the present emergency to hold exhibits.

Redistricting of Sections

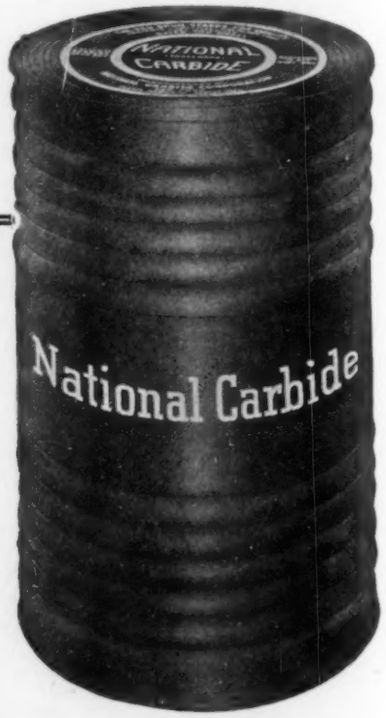
It was voted that recommendation of the Section Officers in regard to redistricting of the Sections be referred to a committee composed of the District Vice-Presidents, with the Middle Eastern District Vice-President as Chairman.

Consolidation of Membership Grades

It was voted that Headquarters make a comprehensive study of statistics to determine the effect upon the Society's

National
Carbide
IN THE RED DRUM

EFFICIENT
ECONOMICAL
DEPENDABLE



FOR WELDING and CUTTING
Use National Carbide in the Red Drum
60 E. 42nd St. NATIONAL CARBIDE CORPORATION New York, N. Y.

DIALARC A. C. WELDER

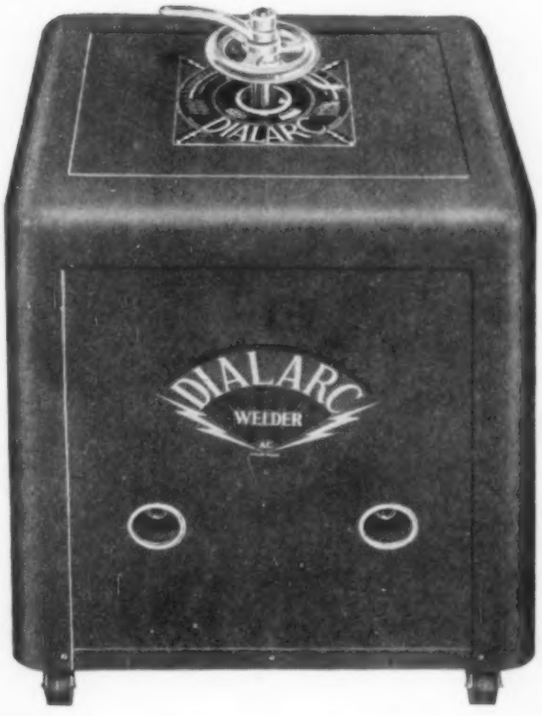
The first to give Perfect Amperage Control

EVEN TO A SPLIT AMPERE
From 15 to 230 AMPERES
Without Any Change
in the Open Circuit Voltage
Built for continuous operation and abuse hour after hour and at exceptionally
Low Current Cost

Every
DIALARC
is covered by a
5-YEAR SERVICE GUARANTEE
underwritten by an insurance policy

Tested and Approved by the UNDERWRITERS' LABORATORIES
A definite GUARANTEE of SAFETY and PERFORMANCE

Designed for
ARC QUALITY
that affords easy striking and the maintenance of a steady arc even in the Lowest Ampere Range.



The
DIALARC
DOES AWAY WITH "MAGNETIC BLOW"
So more rod is uniformly deposited per hour of welding time.

The
DIALARC Represents years of research and experimental work in its UNIQUE AND EXCLUSIVE FEATURES.

, **Our Variable Reactor**
(patents pending)
gives the **DIALARC** perfect stepless control and a far greater range than any other welder on the market.

The open circuit voltage of the **DIALARC** is 80 volts, which gives excellent striking qualities from the lowest to the highest heats without any disadvantages.

This open circuit voltage is **constant** throughout the entire range, due to our specially designed **Variable Reactor**. With this we **do not** have to go down into the transformer and change our open circuit voltage in order to get the necessary amperage needed for good control.

The operating cost of the **DIALARC** is **much less** than that of a D. C. machine of the same capacity.

The **DIALARC** automatically uses current only while the arc is maintained. There is no heavy motor to keep running with a Dialarc.

Its unique construction is protected by a **non-magnetic housing** that prevents "damping-out" and assures a fast, snappy welding arc.

Inquiries invited from well established distributors of welders' equipment and supplies in states east of the Rockies.

SHOBER SALES INC.

536 SO. AURORA STREET MANUFACTURERS AND DISTRIBUTORS **STOCKTON, CALIFORNIA**

THE DIALARC—COSTS LESS AND ITS UPKEEP IS PRACTICALLY NIL

finances of consolidation of membership grades, and render data that will enable the Executive Committee to properly act on the Section Officers' recommendation for a reduction in the number of membership grades.

Membership Application Form

It was voted that recommendation of the Section Officers regarding a revision of the present membership application form be referred to the Committee on Admissions for study with request for report thereon to the Executive Committee. In this study it was believed desirable that the Committee on Admissions confer with the Membership Committee.

Extension of Time for Consideration of By-Law Amendments

It was voted that By-Law amendments be published in THE WELDING JOURNAL thirty days in advance of their submittal to the membership for letter ballot vote.

Outline of Work Committee Recommendations

Personnel Changes.—It was voted to approve recommendations of the Outline of Work Committee of appointment of the following representatives on technical committees of other societies:

American Standards Association

A10—Safety Code for Construction Work: A. N. Kugler.

A57—Building Code Requirements for Iron and Steel: T. R. Higgins, L. M. Dalcher (Alternate).

B31—Code for Pressure Piping: D. H. Corey, F. C. Fantz, L. M. Dalcher (Alternate), T. W. Greene (Alternate).

C42—Electrical Definitions: R. W. Clark, L. M. Dalcher (Alternate).

C52—Electric Welding Apparatus: J. H. Blankenbuehler, L. M. Dalcher, J. W. Sheffer.

C67—Preferred Voltages—100 Volts and under: I. B. Yates.

Z2—Protection of Heads, Eyes, etc., of Industrial Workers: H. S. Smith, H. F. Reinhard (Alternate).

Z5—Ventilation Code: H. S. Smith, H. F. Reinhard (Alternate).

Z14—Drawings and Drafting Room Practice: Proposed to withdraw representation.

Z28—Work in Compressed Air: E. Vom Steeg.

Z32—Graphical Symbols and Abbreviations for Use on Drawings: L. C. Bibber.

American Society for Metals

Metals Handbook Committee assisted by Advisory Committee of: H. L. Maxwell, R. H. Aborn, C. H. Jennings, A. B. Kinzel, G. S. Mikhalapov, A. J. Moses.

International Acetylene Association

Committee on Welding and Cutting Chapters of A. S. M. Metals Handbook: C. H. Jennings, H. L. Maxwell, E. W. P. Smith, R. W. Clark.

American Society for Testing Materials

Committee A-1 and Subcommittee XXI: J. H. Deppeler, *Chairman*, J. J. Crowe, L. M. Dalcher, J. H. Humberstone, C. H. Jennings.

Committee B-5 on Copper and Copper Alloys: I. T. Hook.

Committee A-10 on Iron Chromium, Iron Chromium Nickel and Related Alloys: L. H. Johnson.

American Institute of Electrical Engineers

Committee on Electric Welding, Subcommittee on Power Supply for Welding Operators: W. F. Hess, G. S. Mikhalapov.

American Petroleum Institute

Subcommittee on Field Welding of Casing: J. J. Chyle, P. D. McElfish, L. Van Ormer.

American Transit Engineering Association

Technical Subcommittee Assignment No. 5-40: J. B. Tinnon.

Association of American Railroads

Committee on Fusion Welded Tank Car Tanks: J. J. Crowe.

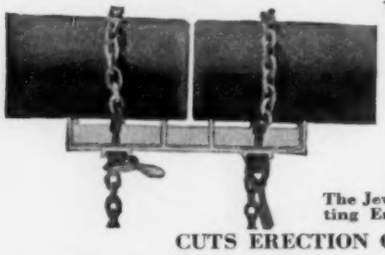
American Coordinating Committee on Corrosion

H. L. Maxwell

Welding Symbols and Instructions for Their Use

It was voted to approve the proposed changes in *Welding Symbols and Instructions for Their Use* and make available the revised Symbols in pamphlet form and in the new Handbook.

PIPE WELDING TOOLS THAT MAKE WELDING PAY



Pipe Clamps
Flange Clamps
Elbow Clamps
Angle Clamps
Pipe Markers

TWO SIZES
½ to 8 in. 8 to 16 in.
Light—Adjustable—Fast

The Jewel System of Pipe and Fitting Erection Ready for the Weld

CUTS ERECTION COSTS

Keeps the Welder Welding Instead of Waiting

JEWEL MANUFACTURING COMPANY
1841 University Ave., St. Paul, Minn.

Buy "Proven Fluxes" with Years of Guaranteed Satisfaction behind them

The Trade-Name is "ANTI-BORAX"

Ask for Them ***Unequalled for Quality***

A Flux for every metal: Cast Iron Welding Flux No. 1; Brazing Flux No. 2; Braz-Cast Flux No. 4, for bronze-welding cast iron; "ABC" Aluminum Flux No. 8 for sheet Aluminum and all alloys of Aluminum; Stainless Steel Flux No. 9; Silver Solder Brazing Flux No. 10; "Anti-Borax" Tinning Compound No. 11.

Send for Free Samples

ANTI-BORAX COMPOUND COMPANY
Fort Wayne, Indiana

MALLORY STANDARDIZED WELDING ELECTRODES

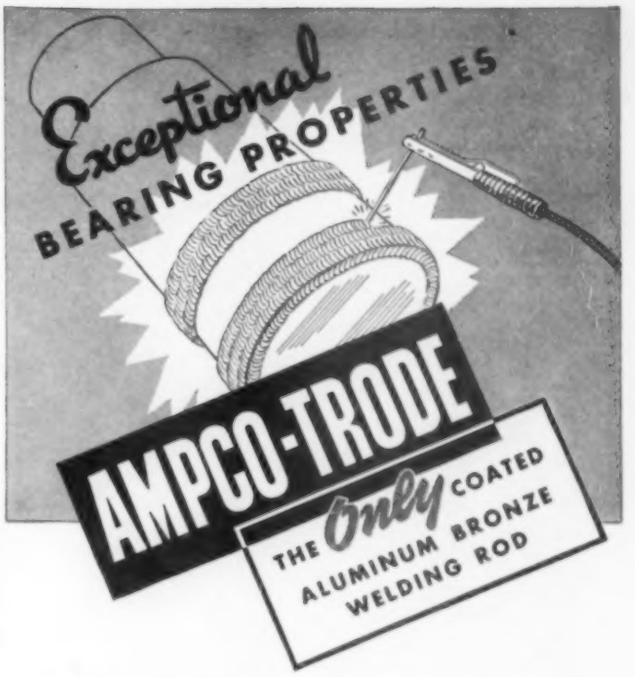
SPEEDIER PRODUCTION
LESS DOWN TIME
BETTER WELDING
LOWER COST

Spot welding speeds plane production. Seam welding speeds shell production. Flash and butt welding speed tank and jeep production. Mallory tips and holders, wheels and dies speed resistance welding all along the production front. Write today for your free copy of the factual Mallory Resistance Welding Data Book.

P. R. MALLORY & CO., Inc., INDIANAPOLIS, INDIANA • Cable Address — PELMALLO

INDEX TO ADVERTISERS

Air Reduction Sales Co. . . Outside back cover
American Brass Company 121
American Chain & Cable Company, Inc. . . . 127
American Welding Society 148
Ampco Metal, Inc. 125
Anti-Borax Compound Company 124
Arcos Corporation . . . . . Inside front cover
Bastian-Blessing Co. 126
Chicago Bridge & Iron Co. 129
General Electric Company . . . Insert 146 & 147
Haynes Stellite Company 133
Hobart Bros. Co. 79
Jewel Manufacturing Company 124
Kelley-Koett Mfg. Co. 131
The Linde Air Products Company 82
Lincoln Electric Co. . . . . Inside back cover
P. R. Mallory & Co., Inc. 124
Metal & Thermit Corporation 137
National Carbide Corporation 122
National Cylinder Gas Co. 135
Oakite Products, Inc. 126
Page Steel & Wire Division 127
Resistance Welder Mfrs. Association 139
Shober Sales, Inc. 123
Square D Company 140
Stulz-Sickels Company 128
Union Carbide and Carbon Corp. . . 82 & 133
Victor Equipment Co. . . . . Insert 143 & 144
Westinghouse Electric & Mfg. Co. 145



WHEN overlaying steel or cast iron to form a bearing surface, use Ampco-Trode coated aluminum bronze welding rods for longer life, better service, and ease of application.

Here is a rod that is ideal for this job. It not only has outstanding physical properties, but has been used for years as a bearing material in heavy machinery, machine tools, and literally hundreds of maintenance services. Possessing the properties of Ampco Metal, it has toughness and wear-resistance to a remarkable degree. Produced in six grades with a hardness range from 100 to 375 Brinell, it is ideal for hard overlays for heavy bearing service.

Ampco-Trode weldrods are suitable for metallic arc, carbon arc, or oxy-acetylene welding. They may be procured in six sizes—from 1/8" to 1/2".

FREE BULLETIN

The welding technique for using Ampco-Trode weldrods and their use on steel, cast iron, bronze, and other alloys is fully discussed in a bulletin recently issued. Ask for your copy—or write regarding welding problems.

AMPCO METAL, INC.
Dept. WJ-2 Milwaukee, Wisconsin

Code for Arc and Gas Welding in Building Construction

It was voted to approve recommendation of the Outline of Work Committee for the adoption and publication of the 1941 edition of *Code for Arc Welding and Gas Cutting in Building Construction* as a tentative standard.

The following scope of committees pro tem was approved.

Committee on Standard Procedures of Welding and Standards for Welded Joints. Scope.—To prepare recommended procedures for manual arc and gas welding, as a means of disseminating information on best welding practices and effecting general improvement of weld quality; to include in the recommended welding procedures such details as the design of the joint, the type of base metal and filler metal to be used, the position in which the welding is to be done, the method of depositing the weld, the use of preheating and postheating, the employment of special welding sequences, and the use of chipping, peening and heat treatment, to undertake first the preparation of procedures for welding materials of the P1-01 grouping as listed in the *A. W. S. Tentative Standard Qualification Procedure.*

Committee on Weldability Tests for Steel. Scope.—To prepare a standard on methods of conducting tests for weldability of steel, giving detailed information on the purpose and application of the tests, the dimensions of the specimens, the manner of preparing the specimens, the procedure for testing the specimens and the methods of evaluating and interpreting the results.

1941 Annual Meeting

Report on Finances and Registration of the 1941 Annual Meeting showed an excess of income over expenses, exclusive of overhead costs, in the amount of $230.71, a registered attendance of 1768, number of welding exhibitors as 31 and the dinner attendance as 513.

National Metal Exposition and Congress

It was voted to authorize the Convention Committee to effect arrangements for holding the A. W. S. Annual Meeting at the same time and place as the A. S. M. Meeting in the years 1942, 1943 and 1944, providing adequate hotel accommodations can be secured.

Further, it was voted to accept the A. S. M. invitation to participate in the National Metal Exposition and Congress in the years 1942–43 and 1944 if held in these years.

Report of Finance Committee

The results of the audit of the books of the SOCIETY for the fiscal year ending September 30, 1941, were approved. This report was published in the Year Book of the SOCIETY. A budget was presented for the year 1941–42.

In presenting the budget for 1941–42, it was reported that a careful study had been made by the Finance Committee of the past fiscal year's actual operations and of the possibilities for the ensuing year. Items of income have been estimated to be productive of nominal increases over the past year's revenue. On the expense side, the principal items scheduled for an increase include journal printing and expense, office rent, salaries, employees' retirement insurance, section refunds and the Year Book. Because of the inadequacy of the space now occupied by Headquarters, it was explained that an investigation was made of available additional space in the Engineering Societies Building and the proposed $1200 increase for rent represents 519 additional square feet of office space.

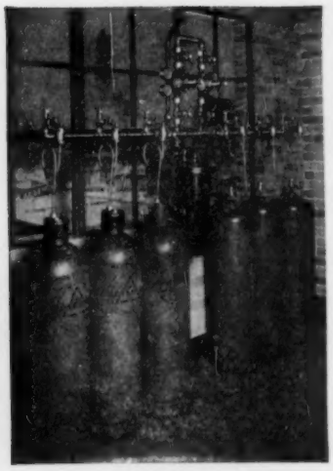
Resistance Welding Prize Contest

It was voted to accept invitation of the R. W. M. A. contained in its communication of December 1, 1941, for the administration of $1000 in prizes, for the appointment of a committee, consisting of Dr. W. F. Hess, *Chairman*, C. A. Adams and L. W. Clark, to judge the merits of papers submitted in the Third R. W. M. A. Prize Contest, and to make the awards in accordance with the decision of these judges. The rules governing the award of this Contest are published in the Year Book of the SOCIETY.

J. HARRY JACKSON

J. Harry Jackson has been appointed a research engineer on the technical staff of Battelle Memorial Institute, Colum-

For SAFETY SPEED ECONOMY



MANIFOLDS
REGULATORS
VALVES and
FITTINGS
to control high pressure gases

REGO

The BASTIAN-BLESSING Co.
4241 PETERSON AVE. CHICAGO

Pioneers and Manufacturers of Precision Equipment for Using and Controlling High Pressure Gases

CLEANING IMPROVES WELDING!

New, FREE, 32-Page Booklet Describes Speedy, Low-Cost Cleaning Methods!

Is arc, gas or resistance welding of aluminum alloys, stainless steel or other metals an essential war production operation in your plant? Then find out how Oakite cleaning can HELP YOU turn out more work, save time and improve welding results! Specially designed Oakite materials are available that thoroughly, speedily remove oil, grease and other foreign matter to assure better, more uniform, stronger welds . . . make welding easier and faster. NEW booklet FREE on request.

OAKITE PRODUCTS, INC., 18E Thames Street, NEW YORK, N. Y.
Representatives in All Principal Cities of the United States and Canada

OAKITE Specialized CLEANING
MATERIALS METHODS SERVICE FOR EVERY CLEANING REQUIREMENT

There's the STAINLESS STEEL WELDING ELECTRODE YOU WANT"

• It's listed on page 6 of this booklet on Stainless Steel Welding and Electrodes that has been prepared by PAGE.

•

You probably know as well as we do that you must look for and insist on getting two distinctly different *kinds* of quality in your Stainless Steel Electrodes.

It is imperative for good Stainless Steel Welding that the deposit *in the weld* be equal to the Stainless Steel you are welding.

It is just as important that the electrode be of the shield-arc type, to protect the metal in the weld; equally usable in horizontal, vertical and overhead positions; permit high speed welding with minimum spatter and slag loss and smooth beads.

To get all those qualities for you, PAGE worked in the field and laboratory with the world's largest producers of Stainless Steel —until they said every PAGE Stainless Electrode was *right*.

Start right, then, with your Stainless welding. Depend on PAGE. Tell your local PAGE Distributor the Stainless Steel you want to weld and accept his recommendation.

Be sure to ask your local PAGE Distributor for a copy of this valuable, well illustrated booklet on the welding of Stainless Steels. It covers the entire subject.

PAGE WELDING ELECTRODES

PAGE STEEL AND WIRE DIVISION • MONESSEN, PENNSYLVANIA

AMERICAN CHAIN & CABLE COMPANY, Inc. BRIDGEPORT, CONNECTICUT

bus, Ohio, and has been assigned to research in metallurgy.

A graduate of Rensselaer Polytechnic Institute, Mr. Jackson was associated with the Caterpillar Tractor Company, Peoria, Ill., as metallurgist and welding engineer for five years prior to joining the Battelle staff. He is a member of the American Society for Metals and Sigma Xi, national honorary science society.

PRACTICAL ARC WELDING

Practical Arc Welding. A textbook by W. J. Chaffee. 516 pages. 512 illustrations. Flexible, red fabrikoid cover. Copyright 1942. Published by Hobart Trade School, Inc., Troy, Ohio. Obtainable from the publisher, or any authorized Hobart distributor, or at most book stores. Price postpaid anywhere in the United States, $2.00.

Part I in the book is devoted to general welding information. Material covered includes the growth of arc welding; where arc welding is used; manufacturing applications; available metals and alloys; discussion of joints and welds; electrodes and filler rods; strength of arc-welded joints; cost of arc welding; characteristics of the welding arc; welding symbols and their use; equipment for arc welding; development of welding personnel.

Parts II and III of the textbook are devoted to the complete series of arc-welding lessons. This group of 41 lessons covers preliminary instructions; starting and manipulating the arc; common joints with bare electrodes; welding light gage sheets with coated electrodes; welding with coated rods in all positions; pipe welding; welding cast iron; special tests; welding with the carbon arc; "long arc" method of welding copper; and specialized applications of arc welding.

Parts IV and V contain a complete dictionary of welding terms and twenty pages of helpful data for operators and designers. The handbook also has an eight-page cross-reference index for the reader's convenience.

BLUE PRINT READING BOOK

Simple Blue Print Reading with Special Reference to Welding, Second Edition, published by The Lincoln Electric Company, Cleveland, Ohio; 146 pages, 5½ by 8½ inches; 96 drawings; cover—semi-flexible simulated leather, gold embossed; price 50 cents per copy, postpaid anywhere in U. S. A., 75 cents elsewhere.

This book is concisely written in simple, practical language for easy understanding. It is intended that welders, mechanics and others will be enabled, by a few hours' spare-time study, to learn print reading which otherwise might take many months to learn.

More than 50 drawings have been revised in the new edition of the volume, which is designed to aid and instruct anyone who must read blue prints, although the book has been especially published for those in the welding field.

The new book also contains eight new pages of drawings in addition to those previously used.

ARC WELDING

Arc Welding—Shipyard Practice and Training Course, by A. L. Deane, New York Shipbuilding Corporation, 1941, 282 pp. (distribution limited). Price $0.50.

This is the most comprehensive training manual geared to shipyard arc welding practice that has been published within recent years. It was prepared by Mr. Deane, Assistant Foreman in charge of welding in the turret shop of the New York Shipbuilding Corporation, under the general direction of the Welding Engineering Department. The material presented is based on many years of experience in training arc welders in a plant ship welding school formerly operated by this shipyard. Orders for this book should be addressed to: J. H. Dilks, Librarian, New York Shipbuilding Corp., Camden, N. J.

NEW CABLE REPAIR METHOD

As mining operations are extended, both the tracks that carry the mine cars and the copper trolley cables from which they

SAVE STEEL FOR NATIONAL DEFENSE

By Welding

Jaw Plates, Gyratory and Roll Crushers, Shovel Teeth, Hammers, Tractor Tread Grousers, R. R. Frogs and Crossings. Dredge Pump Parts, etc.

with

MANGANAL

11 to 13½% Manganese Nickel Steel

WELDING ELECTRODES

Bare, Standard and Special Tite-Kote

APPLICATOR BARS

Round, Square, Flat, Special Shape

Hot Rolled Plates. Cast Wedge Bars.

STULZ-SICKELS CO. *Sole Producers* 134-142 Lafayette St., Newark, N. J.

Sold Thru Distributors Only

NET ADVERTISING RATES

Black and White *Effective May 1938*

Space	One Insertion	Three Insertions	Six Insertions	Twelve Insertions
*Full Page	$100	$90	$80	$70
Half Page	60	50	45	40
Quarter Page	35	30	27	25
Eighth Page	25	20	17	15
*Inside Preferred	115	105	95	85

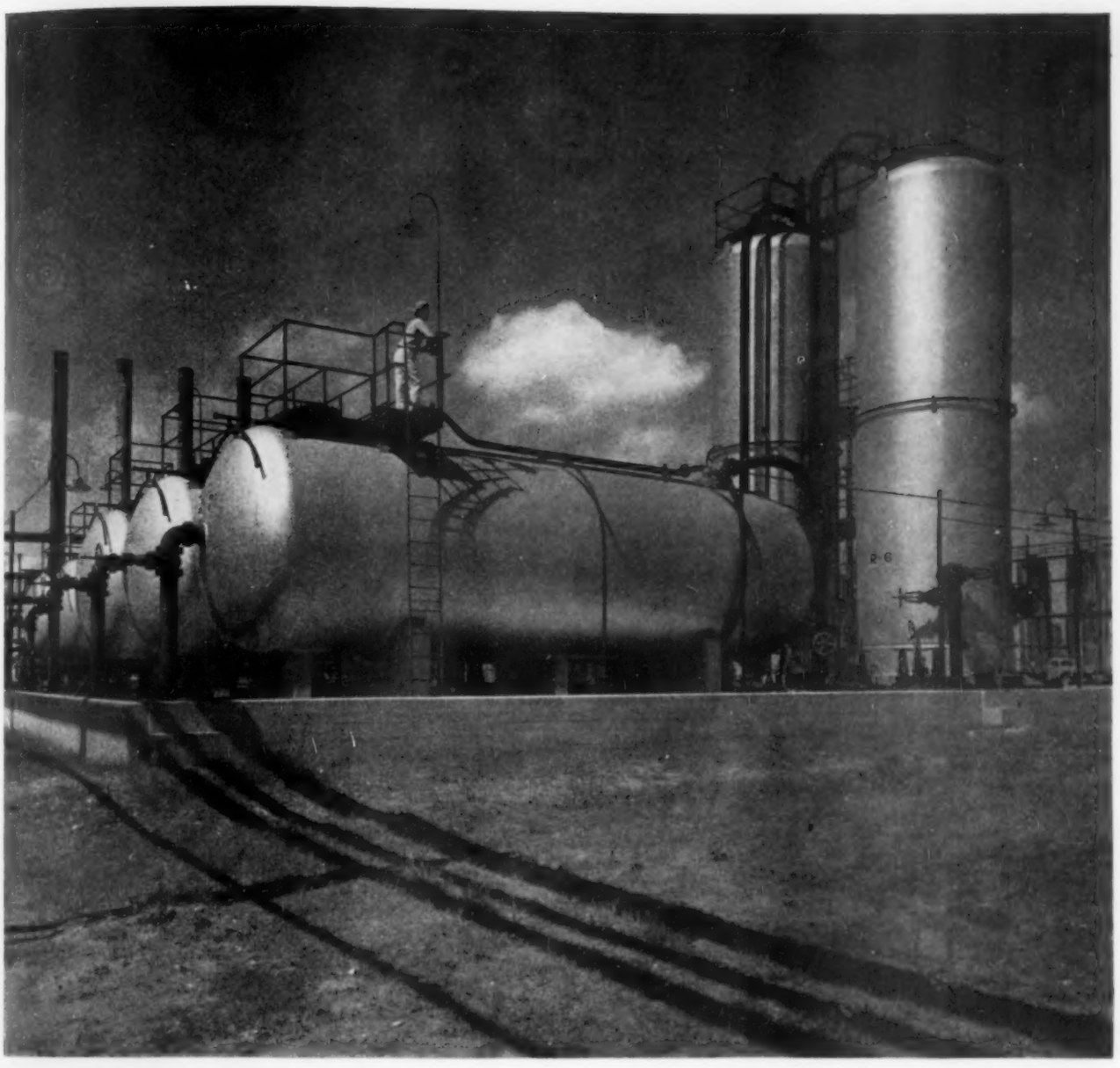
*10% Extra for bleed full pages. Color $40 Extra per color added.

Welding Metallurgy

A comprehensive book of 17 chapters, 359 pages. Completely illustrated. Prepared by Prof. O. H. Henry & Dr. G. E. Claussen. Price $1.50.

AMERICAN WELDING SOCIETY

33 West 39th Street, New York



CYLINDRICAL PRESSURE VESSELS

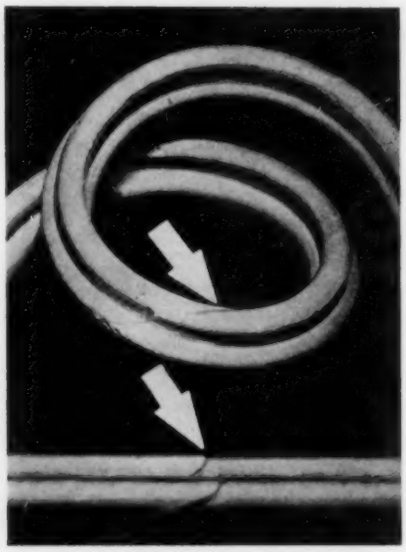
. . . . of welded construction

Many process industries utilize pressure vessels like the ones illustrated above in a gasoline treating unit at a modern oil refinery. There are two 10 ft. diam. by 30 ft. high, three 10 ft. diam. by 30 ft. long, two 8 ft. diam. by 30 ft. long and one 10 ft. diam. by 10 ft. long. We have facilities at Birmingham for x-raying and stress-relieving structures designed in accordance with Paragraph U-68 of the ASME Code and build Paragraph U-69 or API-ASME vessels at our other plants.

CHICAGO BRIDGE & IRON COMPANY

Chicago.....2455 McCormick Bldg.	Birmingham.....1507 North 50th Street	Philadelphia.....1668–1700 Walnut Street
New York.....3398—165 Broadway Bldg.	Tulsa.....1654 Hunt Bldg.	Havana.....402 Edificio Abreu
Cleveland...2282 Builders Exchange Bldg.	Houston.....5621 Clinton Drive	San Francisco.....1097 Rialto Bldg.
Washington.....632 Washington Bldg.	Detroit.....1556 Lafayette Bldg.	Los Angeles.....1471 Wm. Fox Bldg.

Fabricating plants in CHICAGO, BIRMINGHAM and GREENVILLE, PA.



get power to operate must often be extended and shifted to new locations.

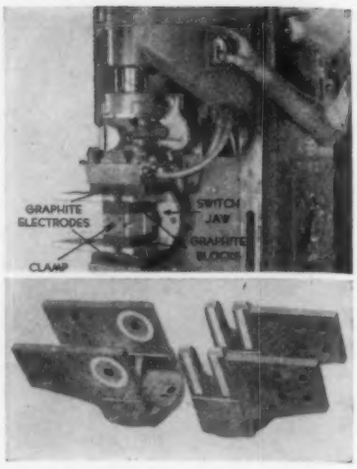
Installation men, in an effort to speed up this work and save the metal in the large brass splicers they have used in the past for extending cables, have experimented with low-temperature silver alloy brazing and find that brazing is far less costly and more efficient than the methods formerly used.

When instructions come through for an extension of tracks the end of the existing cable and the new cable to be added are cut diagonally with a hack saw (see the illustration). The two pieces are then butted together and held firmly in place with a suitable jig. The surfaces to be joined are brushed with special flux (a low-temperature brazing flux which is active at 1100° F.). Heating is done by oxyacetylene torch which brings the joint up to brazing temperature rapidly. A silver brazing alloy (Easy-Flo, flowing at 1175° F.) is touched to the heated parts as soon as they show a dull cherry red heat and penetrates instantly throughout the joint. This operation takes only five minutes and provides a connection which electrically is as efficient as a continuous cable. The strength of the braze also is as high or higher than that of the solid cable. As a joint of this type is free from internal oxidation, the need for cleaning or other maintenance is eliminated.

The gases for heating and the brazing alloy for the job illustrated cost only five cents for each complete braze. The brass splicers formerly used cost about $1.23 each. This cable joining method saves time and improves joint quality. Its effectiveness may also suggest other metal joining operations which will release metals needed for war materials, now being used for repair and maintenance.

ELECTRIC BRAZING

An interesting illustration of the attachment of contact materials to heavy copper castings may be noted in the accompanying photograph of 4000-amp. disconnect switch jaw and hinge to which strips and rings of silver-nickel contact material (Gibsiloy Grade-A) were brazed by the Gibson Electric Company of Pittsburgh. Eight strips $^1/_{64}$ x $^1/_2$ x $3^1/_2$ in. were brazed to the jaw and four rings $^1/_{64}$ in. thick, 3 in. O.D., $2^1/_8$ in. I.D. were brazed to the hinge. Each casting weighed 35 lb. All of the contacts on each casting had to be brazed at one time; otherwise the bonds of the contacts first brazed might be damaged by the heat required to braze the other contacts.



To accomplish this, the contacts were placed on the casting and the casting held between graphite electrodes of a 50-kva. welding machine, the outer contacts being held by these electrodes. The inner contacts were also held between graphite blocks which were pressed against the contact material by means of the wedging clamp illustrated. Very little of the current passed through this inner clamping device because it was by-passed by the base of the copper casting itself. Most of the heat was therefore generated in the outer electrodes and the casting had to be brought up to heat slowly in order to give time for as nearly an even distribution of heat as possible, so that the inner contacts could be brazed before the outer contacts tended to melt.

The brazing medium was silver solder which had been applied as a solder flushing on the sheets of silver-nickel from which the contacts were made.

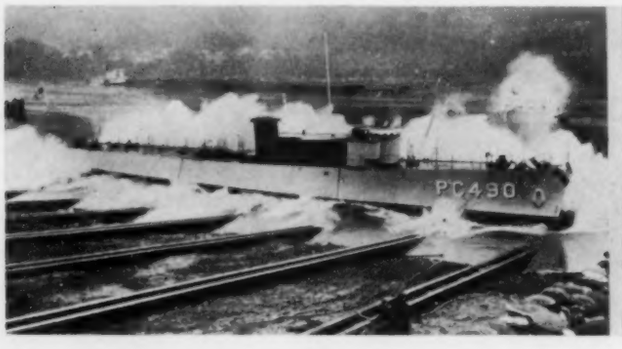
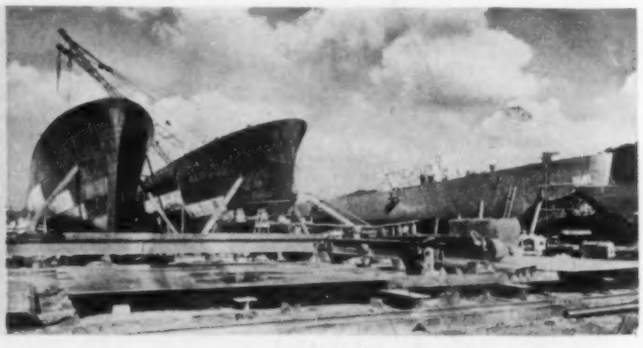


Fig. 1—The All-Welded $600,000 PC-490, First of 15 All-Arc-Welded Submarine Chasers to Be Built by the Dravo Corporation, Slides Into the Water at Pittsburgh



Photos courtesy The Lincoln Electric Company, Cleveland, Ohio

Fig. 2—A View of Three Arc-Welded Hulls, Each 165 Ft. Long, on the Production Line

PRODUCTION OF SUB-CHASERS SPEEDED BY WELDING

Production line methods have been applied to the construction of arc-welded submarine chasers at Pittsburgh, Pa., where 15 of the diesel-powered vessels are being constructed by the Dravo Corporation.

When the PC-490, shown splashing into the Ohio River in Fig. 1, was completed, it was the first time in three-quarters of a century that a warship had been launched in the Pittsburgh area. Now, because of the rapidity of arc welding and the production line setup, one of these boats is scheduled to slide into the river each month, until the 15 are completed. The boats are all welded.

The vessels are 165 ft. long and cost $600,000 each. These craft are built in sets of three, upside down and in three sections. When the hulls are completed, the vessels are righted and placed on the ways.

GENERAL MOTORS (Aero Products)
DELCO-REMY
FRIGIDAIRE CORPORATION
FORD MOTOR CO.
ROCK ISLAND ARSENAL
C. F. BRAUN & CO.

INTERNATIONAL SILVER CO.
NEW JERSEY ZINC CO.
BADENHAUSEN CORPORATION
A. O. SMITH CORPORATION
NORTHERN PUMP CO.

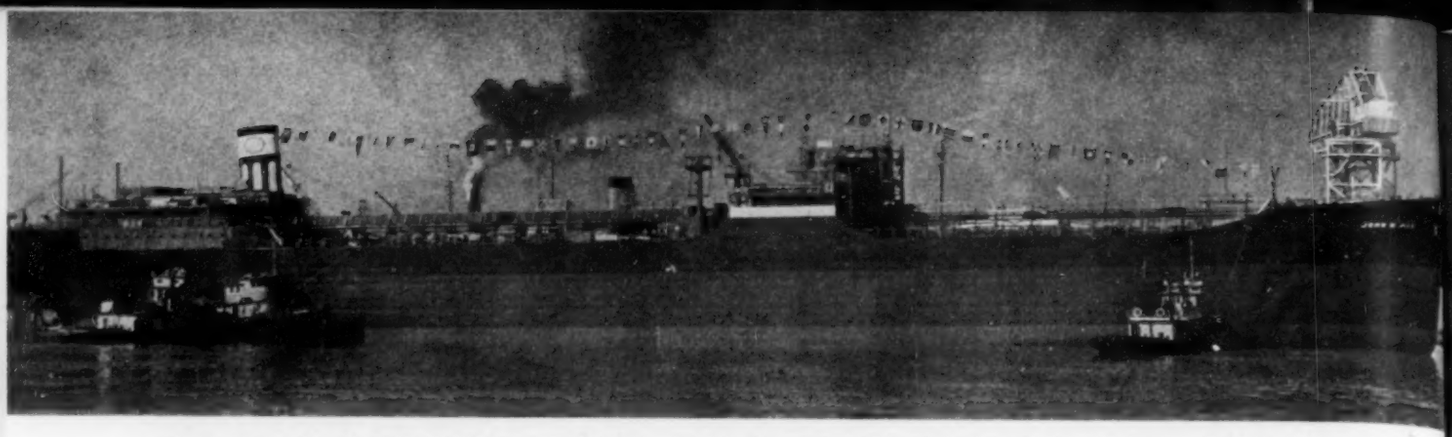
X-RAY INSPECTION a MUST for War Work!

★ **War** material specifications are requiring an increasing amount of X-ray inspection of castings, forgings, sheets, plates and all welded seams and joints. As pioneers in the field of industrial X-ray, we will be glad to consult with you and study your requirements. There are KELEKET representatives in 64 industrial centers who will advise the quickest and most practical way for your plant to either adopt or extend X-ray inspection. Write us today.

THE KELLEY-KOETT MFG. CO. • COVINGTON, KY.
Representatives in 64 Cities

BUY KELEKET IN '42

PIONEER CREATORS OF *QUALITY* X-RAY EQUIPMENT SINCE 1900



View of the SS. JOHN D. GILL, Seventh Vessel of a New Fleet of Atlantic Refining Company's Tanks Launched November 15th

NEW CODE FOR ARC AND GAS WELDING IN BUILDING CONSTRUCTION

The Society has recently published a tentative *Code for Arc and Gas Welding in Building Construcion, 1941 Edition,* to supercede the former *Code for Fusion Welding and Gas Cutting in Building Construction, Part A, Structural Steel, 1937 Edition.* The new Code was prepared by the Society's Committee on Building Codes, and approved by the Board of Directors on December 11, 1941.

The Code prescribes a set of regulations intended for adoption by municipalities as part of their master building code, to cover the application of arc and gas welding in building construction. It represents a complete revision and considerable amplification of the former Code, which it now supercedes. In addition to a foreword, it contains 6 sections and 6 appendices, as follows: Section 1—General Provisions; Section 2—Design of Welded Connections; Section 3—Filler Metal; Section 4—Workmanship; Section 5— Inspection; Section 6—Qualification; Appendix A—Definitions; Appendix B—Welding Symbols; Appendix C—Prequalified Welded Joints; Appendix D—Qualification of Welding Procedures and Operators; Appendix E—Illustrations of Acceptable and Defective Weld Profiles; Appendix F—Record of Operator Qualification Tests.

The Code is a 74-page document, indexed, with a heavy paper cover Copies may be obtained for 50¢. each by addressing the AMERICAN WELDING SOCIETY, 33 West 39th Street, New York, N. Y.

NEW BOOK ON WELDING TRAINING

A new book prepared primarily to assist instructors in planning courses for the training of oxyacetylene welding and cutting operators has just been published by the International Acetylene Association. The book, "Training Oxyacetylene Welding and Cutting Operators—Instructors Outlines" is divided into three chapters. The first outlines the essential information that should be presented in a course for the training of a general welding operator, an aircraft-welding operator, and a pipe-welding operator. The second chapter contains in outline form the material that is essential to the training of various types of cutting operators. The third chapter outlines the essential information that should be given in a course for inspectors and a specification of the primary requirements of students who take the inspector's course.

The material presented throughout the book has been divided into self-contained units, each of which includes the four essential parts of any particular lesson, namely, an outline for a classroom lecture, suggestions for study assignments, recommendations for the material that should be demonstrated and discussed, and a description of the practice exercises the student should do in the shop.

Copies of this new 88-page book can be obtained by writing to the Secretary of the International Acetylene Association, 30 East 42nd Street, New York, N. Y. Paper bound copies are 25 cents each; Cloth-bound copies are 75 cents each.

WORKMEN FAIL TO JUDGE WELDABILITY

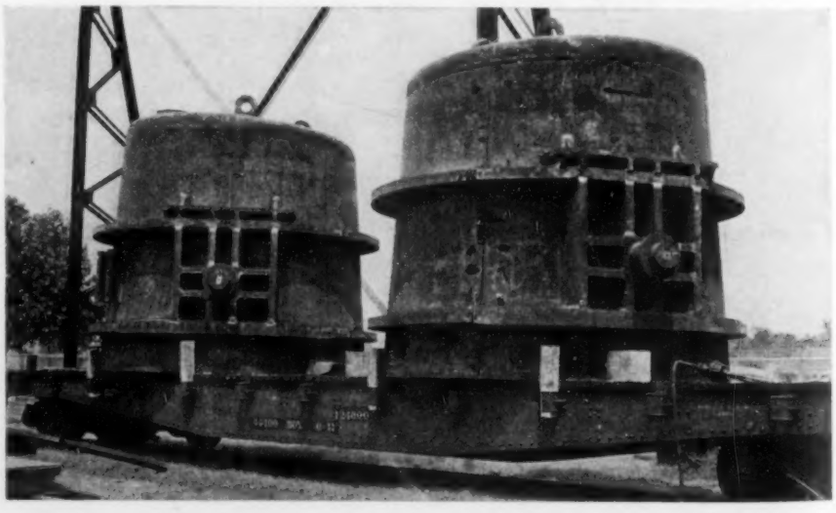
Weldability of welding machines cannot be accurately judged by the average workman according to Charles H. Jennings and Alfred B. White, Westinghouse research engineers. Addressing a convention of the Association of Iron and Steel Engineers, the two men pointed out the need for establishing a standard and developing a scientific method of checking whether or not a machine meets these standards, so that a definite weldability rating can be given to welding machines.

Five types of welding units were tested by each of 20 operators participating in an experiment at the Westinghouse East Pittsburgh works. Although the characteristics of the machines differed widely, each could have been considered ideal for the job according to requirements established by different theories. The results of the test showing the time each welding machine was rated "best" and "poorest" were as follows:

Machine	"Best"	"Poorest"
1	5	4
2	4	2
3	2	6
4	4	4
5	4	2

Two possible conclusions may be drawn from a test of this kind, according to Mr. Jennings: under the conditions of the test the electrical characteristics of a machine are not critical, and weldability is a matter of personal judgement.

Ladles Fabricated by Welding



Two of Six 140-Ton Ladles Fabricated by Welding at the Birmingham Plant of the Chicago Bridge & Iron Co. for the Tennessee Coal., Iron & Railroad Co. Ladles Are 10 Feet 5 Inches in Diameter at the bottom, 11 Feet 3 1/4 Inches at the Top and 11 Feet 3 1/2 Inches Deep

Solve Replacement Problems

by Hard-Facing with Haynes Stellite Rods

AS replacement parts for industrial machines and equipment become increasingly hard to get, it is more important than ever to prolong the life of wearing parts now on the job. In many cases, this can be done most successfully by hard-facing with Haynes Stellite Company rods.

Hard-Face All Parts— Old and New

Old parts which are badly worn can be reclaimed and armored against wear by applying Haynes Stellite rods. To assure maximum savings, it usually pays to hard-face new parts—*before* wear occurs. Then when long use finally does impair their efficiency, most parts can be hard-faced again and again for added service.

Other Advantages of Hard-Facing

The use of Haynes Stellite hard-facing materials frequently permits use of cheaper base metals—or makes possible the use of a readily available substitute base metal when the usual kind cannot be obtained. When cutting or scraping edges are hard-faced, they stay sharp longer, often reducing power consumption. Time out for repairs is cut down by hard-facing, and this helps maintain high production schedules. At the same time, hard-facing decreases maintenance work and solves many replacement problems. Wherever abrasion . . . impact . . . heat . . . or corrosion . . . take their toll, there's a Haynes Stellite rod to furnish lasting protection.

A Rod for Every Purpose

Haynes Stellite Rod—the original non-ferrous cobalt-chromium-tungsten hard-facing alloy—now available in three different grades—high in "red hardness," highly resistant to abrasion and corrosion—applied by oxy-acetylene or electric arc process.

Hascrome Rod—iron-base hard-facing rod containing chromium and manganese—work-hardens under impact—applied by oxy-acetylene or electric arc process.

Haynes Stellite "93" Rod—iron-base hard-facing alloy containing more than 40 per cent of alloy ingredients—hard and abrasion-resistant—applied by oxy-acetylene or electric arc process.

Haystellite Inserts—cast tungsten carbide in 13 standard shapes and sizes—extremely resistant to abrasion—generally applied by oxy-acetylene process with high-strength steel rod as binder.

Haystellite Tube Rod—tungsten carbide grains of 9 standard screen sizes in high-strength steel tubes—extremely wear-resistant—applied as hard-facing rod, generally by oxy-acetylene process.

Haystellite Composite Rod—tungsten carbide grains of 4 standard screen sizes uniformly distributed in high-strength steel binder—extremely wear-resistant—applied as hard-facing rod, generally by oxy-acetylene process.

HAYNES STELLITE TRADE MARK

Red hard, wear-resisting alloys of cobalt, chromium and tungsten

HAYNES STELLITE COMPANY

Unit of Union Carbide and Carbon Corporation

New York, N. Y. UCC Kokomo, Ind.

Chicago—Cleveland—Detroit—Houston—Los Angeles—San Francisco—Tulsa

• HEADQUARTERS FOR HARD-FACING MATERIALS •

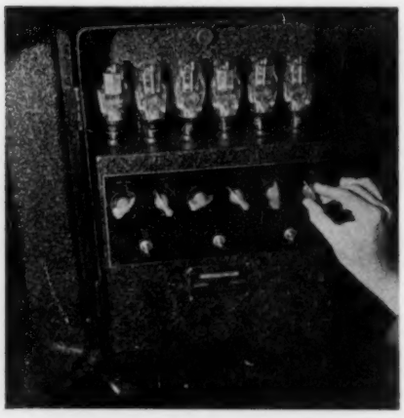
"Haynes Stellite," "Haystellite" and "Hascrome" are registered trade-marks of Haynes Stellite Company.

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

PRECISION TIMING FOR SPOT WELDS

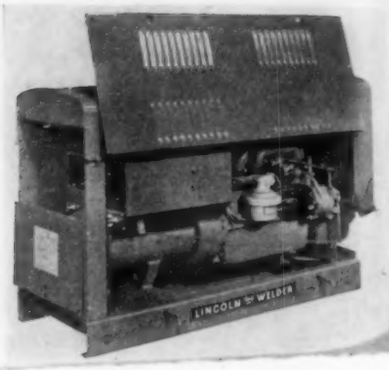
Making a spot weld is a precise process with several rigidly controlled steps. A typical resistance-welding cycle may last from a tenth of a second to three or four seconds, depending on the kind and thickness of metal welded. The total time of a weld is further divided into the various intervals in which the welding machine goes through its operating sequence, and includes a "weld" period (3 to 30 cycles) when the full welding current flows. Sometimes, when welding thick plates or plates of brass or stainless steel that call for careful and critical welding, the material is welded not in one, but in several heating and cooling steps intermittently. A controller for this surface has an "over-all weld" timing sequence, subdivided in several "heat" and "cool" steps, each ranging from 3 to 30 cycles.



This timing is now done by a new controller developed by Westinghouse using plug-in telephone type relays for compactness, and thyratron tubes to actuate them. The operator, in order to establish the automatic timing sequence for the job at hand, simply places the plugs in the proper holes in the panel of the controller. The controls are mounted on hinged dead-front panels, which, for maintenance, can be swung open by removing a single bolt.

TRACK SWITCH

A new electrically operated track switch known as a Motor-Driven Type H Switch has been developed by the Cleveland Tramrail Division of The Cleveland Crane & Engineering Co., Wickliffe, Ohio, for use on cab-operated, gravity or automatic dis-



TIGHT
BOU

welder is reported priced lower than the average shop would expect to pay for a satisfactory "build-your-own" outfit.

Of 200-ampere size (see illustration), this new Lincoln unit is engineered for profitable welding applications of all types and sizes. With a current range of 40 to 250 amp., the machine can be used for the welding of light-gage metal, for the repair of cast-iron parts such as engine blocks, for fabrication of machine parts and structures of many kinds, and for hard-facing of worn parts. Of direct current type, it can weld effectively practically all metals and alloys with bare or shielded arc type electrodes or with the carbon arc where desirable. Its compactness and light weight make it readily portable and hence suitable for work in remote locations as well as those applications which are readily accessible.

The machine's self-indicating voltage control ("job selector") and current control make it easy for the operator to select any type of arc and any arc inten-

---

CUSTOM-BUILT ATOMIC HYDROGEN WELDER

Production of Bren gun magazines in a Canadian munitions plant has been substantially speeded since the recent installation of two General Electric atomic hydrogen welding machines. These machines were custom-built for the precision welding of these vital parts by G-E engineers, working with engineers of the munitions plant.

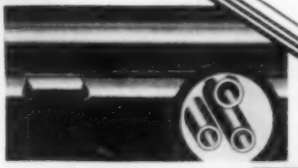
In the original factory at Brno, Czechoslavakia, this task was done by hand welders, working at benches. British manufacturers developed an automatic method, however, by which the outside seams of five magazines were welded at one time after all five magazines were clamped in a fixture. Magazines were then placed in another fixture for welding of inside seams individually.

HTLY

UND

sands of cutting jobs. Here's why!

Special head withstands terrific heat without distorting . . . no leaks from warped head seats . . . no repairs from stripped threads.

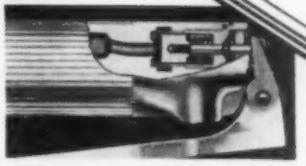


KX TIPS for SPEED and ECONOMY!

On any metal thickness . . . clean or dirty . . . there's a KX tip that will do the job better!

RegO KX tips are designed to give ideal gas mixture for fast and economical preheating . . . and to assure perfect head seating.

Triangular tube arrangement has greater strength and rigidity. Tubes brazed at the head and valve body assure leakproof joints.



High pressure valve assembly in the KX is leakproof . . . special diaphragm replaces packing used in ordinary construction.

Get all facts . . . send for 4-page KX folder!

REGO . . . pioneer equipment for using and controlling high pressure gases . . . distributed by

NATIONAL CYLINDER GAS COMPANY

205 W. Wacker Drive — Chicago, Illinois

Offices in Principal Cities

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

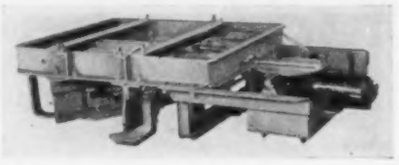
PRECISION TIMING FOR SPOT WELDS

Making a spot weld is a precise process with several rigidly controlled steps. A typical resistance-welding cycle may last from a tenth of a second to three or four seconds, depending on the kind and thickness of metal welded. The total time of a weld is further divided into the various intervals in which the welding machine goes through its operating sequence, and includes a "weld" period (3 to 30 cycles) when the full welding current flows. Sometimes, when welding thick plates or plates of brass or stainless steel that call for careful and critical welding, the material is welded not in one, but in several heating and cooling steps intermittently. A controller for this surface has an "over-all weld" timing sequence, subdivided in several "heat" and "cool" steps, each ranging from 3 to 30 cycles.

This timing is now done by a new controller developed by Westinghouse using plug-in telephone type relays for compactness, and thyratron tubes to actuate them. The operator, in order to establish the automatic timing sequence for the job at hand, simply places the plugs in the proper holes in the panel of the controller. The controls are mounted on hinged dead-front panels, which, for maintenance, can be swung open by removing a single bolt.

TRACK SWITCH

A new electrically operated track switch known as a Motor-Driven Type H Switch has been developed by the Cleveland Tramrail Division of The Cleveland Crane & Engineering Co., Wickliffe, Ohio, for use on cab-operated, gravity or automatic dispatch overhead materials handling systems.



This development enables the Tramrail operator to pre-set the switch at some distance ahead while traveling and thus save time lost when switching by hand. Likewise, indexes on gravity or automatic dispatch carriers may be set to actuate trippers which will cause one or several switches to take the positions desired.

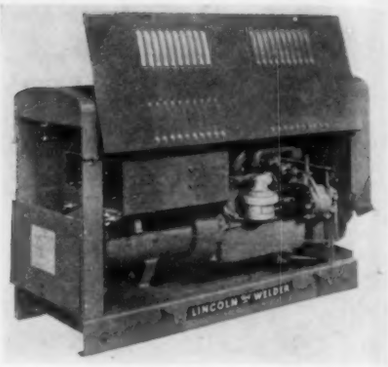
The switch is ruggedly built of welded steel. It consists of two main assemblies—an outer supporting frame and an inner sliding frame. The outer frame is designed for bolting rigidly to the superstructure. The inner assembly carrying a straight and a curved rail rides on multiple, easy-operating rollers, and is set in position by a motor-driven cam through a lever arrangement.

ARC WELDER

A new engine-driven arc welder which is specially designed for job welding and garage work and which embodies a new system of engine-speed control for maximum fuel economy and minimum engine wear, is announced by The Lincoln Electric Company, Cleveland, Ohio. The new welder is reported priced lower than the average shop would expect to pay for a satisfactory "build-your-own" outfit.

Of 200-ampere size (see illustration), this new Lincoln unit is engineered for profitable welding applications of all types and sizes. With a current range of 40 to 250 amp., the machine can be used for the welding of light-gage metal, for the repair of cast-iron parts such as engine blocks, for fabrication of machine parts and structures of many kinds, and for hard-facing of worn parts. Of direct current type, it can weld effectively practically all metals and alloys with bare or shielded arc type electrodes or with the carbon arc where desirable. Its compactness and light weight make it readily portable and hence suitable for work in remote locations as well as those applications which are readily accessible.

The machine's self-indicating voltage control ("job selector") and current control make it easy for the operator to select any type of arc and any arc intensity to suit the job. They provide continuous selection throughout the range.



POWER SWITCH FOR RESISTANCE WELDERS

To speed up production in resistance welding, a power switch called a Weld-O-Trol is described in a new six-page folder announced by Westinghouse Electric and Manufacturing Company.

The use of the Weld-O-Trol to reduce time-outs for maintenance and to eliminate mechanical delay in contact timing is discussed. A schematic diagram shows how the Weld-O-Trol, in sizes of from 150 to 1200-amp. frame, opens and closes the circuit to the primary of the welding transformer.

The selection of Ignitron tubes is simplified by a chart giving proper sizes from kva. values during the welding process. Installation and replacement of Ignitron tubes is described and illustrated.

The electro-thermostatic flow switch to protect against water failure or insufficient water flow in the cooling system is explained and illustrated.

A copy of booklet B-3025 may be secured from department 7-N-20, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

CUSTOM-BUILT ATOMIC HYDROGEN WELDER

Production of Bren gun magazines in a Canadian munitions plant has been substantially speeded since the recent installation of two General Electric atomic hydrogen welding machines. These machines were custom-built for the precision welding of these vital parts by G-E engineers, working with engineers of the munitions plant.

In the original factory at Brno, Czechoslavakia, this task was done by hand welders, working at benches. British manufacturers developed an automatic method, however, by which the outside seams of five magazines were welded at one time after all five magazines were clamped in a fixture. Magazines were then placed in another fixture for welding of inside seams individually.

REGO

KX

CUTTING TORCH

ings speed and economy to
ousands of cutting jobs. Here's why!

Special head withstands terrific heat without distorting . . . no leaks from warped head seats . . . no repairs from stripped threads.

KX TIPS for SPEED and ECONOMY!

On any metal thickness . . . clean or dirty . . . there's a KX tip that will do the job better!

RegO KX tips are designed to give ideal gas mixture for fast and economical preheating . . . and to assure perfect head seating.

Triangular tube arrangement has greater strength and rigidity. Tubes brazed at the head and valve body assure leakproof joints.

High pressure valve assembly in the KX is leakproof . . . special diaphragm replaces packing used in ordinary construction.

Get all facts . . . send for 4-page KX folder!

REGO . . . pioneer equipment for using and controlling high pressure gases . . . distributed by

NATIONAL CYLINDER GAS COMPANY

205 W. Wacker Drive — Chicago, Illinois

Offices in Principal Cities

The General Electric machines permit welding of both sides of the magazines in one fixture at one operation, effecting an important saving in time.

RegO LP GAS POCKET GUIDE

The Bastian-Blessing Company, 4201 Peterson Avenue, Chicago, is offering to the liquefied petroleum gas industry a convenient reference manual in the form of the RegO LP Gas Pocket Guide.

The Guide contains basic data, charts, tables and other information relevant to the industry. It coordinates technical and specialized knowledge in connection with the merchandising and handling of liquefied petroleum gases and is prepared primarily to help the dealers' salesmen and servicemen to a better understanding of liquefied petroleum gas, its characteristics and applications, as well as to furnish information that will be helpful in increasing sales and insuring maximum safety.

Employment Service Bulletin

POSITION VACANT

V-109. Welding Engineer for estimating, design and general welding engineering work. Practical experience in actual welding and supervision of large welding projects desired. Excellent opportunity for right person.

SERVICES AVAILABLE

A-428. Welding Engineer and Metallurgist; young, graduate engineer, desires position in research or development. Experienced in arc, gas, Unionmelt welding, code practice, metallography, testing; experimental work on carbon and alloy steels for pressure vessels and piping; qualification of welding procedures and operators. Competent welder.

A-429. Welding Engineer, 40 years of age, married. B.S. in Industrial Eng. degree from Ohio State University. Took Student Engineering Course at General Electric Co. and Technical Welding Training Course. Training has been in non-pressure welding. Is willing to go into any phase of manufacturing connected with welding.

A-430. Welding Production Manager. Thirty years' practical experience in both Electric and Acetylene Welding. Built up largest production welding business in this country, which also did most of the large outside welding contracts. Retired in good health; 54 years of age.

UNITED STATES CIVIL SERVICE EXAMINATIONS

Principal Field Representative (Apprenticeship), $4600 a year; Senior Field Representative (Apprenticeship), $3800 a year; Field Representative (Apprenticeship) $3200 a year and Assistant Field Representative (Apprenticeship), $2600 a year.

Optional Branches

1. Machine Shop Trades (Machine Tool Construction, Operation, or Maintenance)
2. Aircraft Trades (Construction or Maintenance)
3. Shipbuilding Trades (Construction or Maintenance)
4. Building Trades (Construction)
5. General (Apprenticeable trades other than listed above)
6. Combinations (Any combination of 1, 2, 3, 4, and/or 5 above)

Apprenticeship Section, Division of Labor Standards Department of Labor

Applications must be on file with the United States Civil Service Commission at Washington, D. C., not later than February 16, 1942

List of New Members

December 1 to December 31, 1941

BOSTON

Ober, W. T. (B), Thomson-Gibb Elec. Welding Co., Lynn, Mass.
O'Keefe, William J. (D), 227 Bradford St., Everett, Mass.

CHICAGO

Davis, Will (C), 4750 Pershing Rd., Downers Grove, Ill.
Janda, Frank (C), General Elec. X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill.

CINCINNATI

Eggleston, Dudley (C), Addyston, Ohio.
Gruell, Herbert (C), Route 1, Florence, Ky.
Setzer, Leonard (D), 2110 Sherer Ave., Dayton, Ohio.

CLEVELAND

Miller, Edward F. (C), Electric Welder Repair, 3732 Cedar Ave., Cleveland, Ohio.

COLUMBUS

Birinyi, Louis (F), 178—13th Ave., Columbus, Ohio.
Davis, James (F), Ohio State University, Industrial Engrg. Bldg., Columbus, Ohio.
Edison, Murray (F), 111 E. Woodruff Ave., Columbus, Ohio.
Kearns, William (F), 3057 Sunset Dr., Columbus, Ohio.

DETROIT

Scott, M. R. (C), The Linde Air Products Co., 6-244 General Motors Bldg., Detroit, Mich.

INDIANA

Burrise, Andrew H. (C), 310 N. Illinois St., Indianapolis, Ind.
Leffler, Isaiah R. (D), 2116 N. E. St., Richmond, Ind.

KANSAS CITY

Adolphsen, A. W. (C), 4156 Harrison, Kansas City, Mo.
Fry, W. E. (C), 8124 Lee Blvd., Kansas City, Mo.

LOS ANGELES

Brutcher, Henry (C), 3185 N. Marengo Ave., Altadena, Calif.
Messersmith, John C. (D), 311 S. Fairview, Burbank, Calif.
Ramseyer, F. J. (B), 2928 W. 78th Pl., Inglewood, Calif.

LOUISIANA

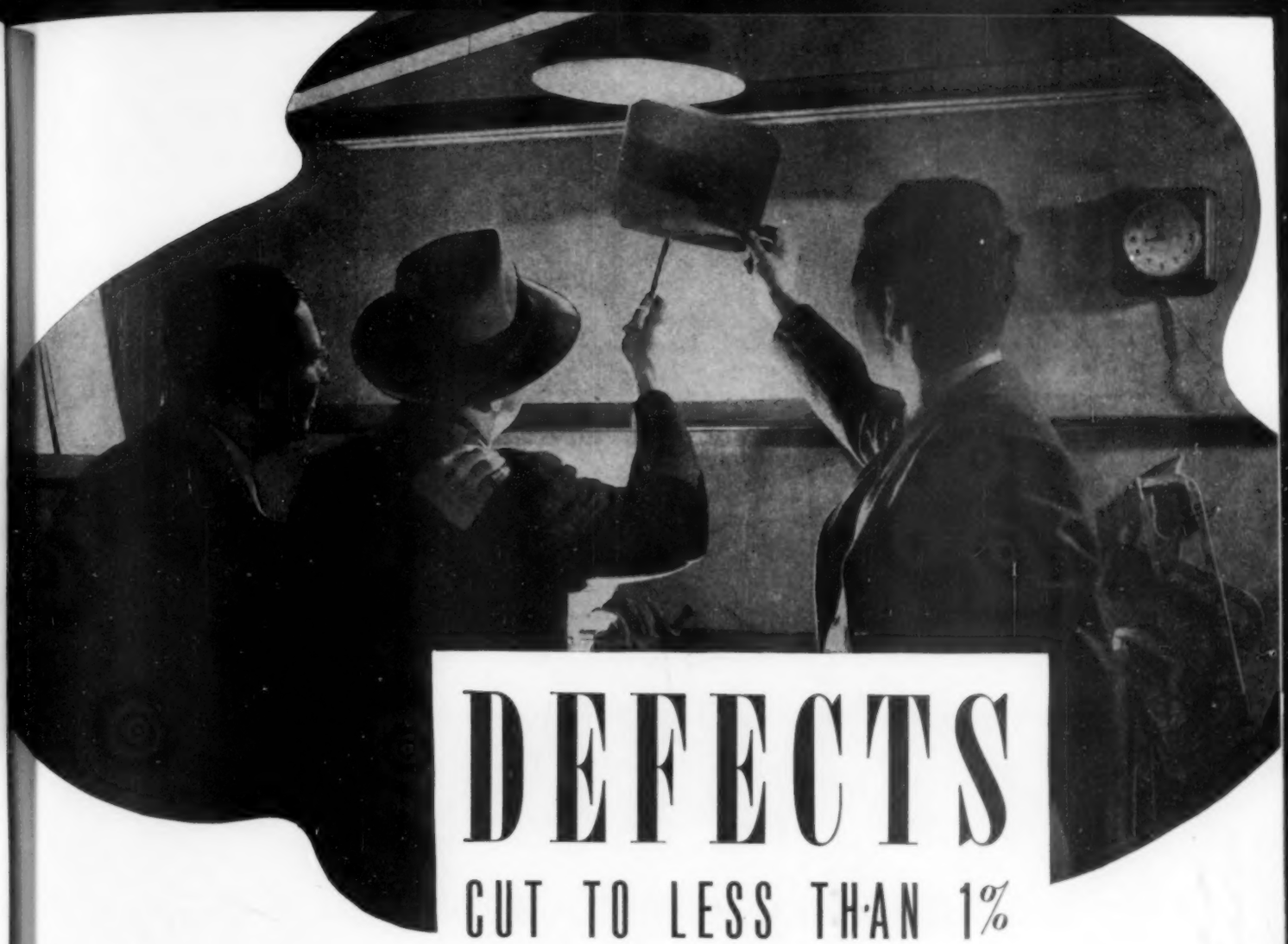
Cockrell, Clifford M. (B), Freeport Sulphur Co., Port Sulphur, La.
Terrell, Earl W. (C), 1636 Hodges St., Lake Charles, La.

MILWAUKEE

Corp, Mrs. Paul M. (C), 2846 N. 46th St., Milwaukee, Wisc.
Frentzel, Herman (B), The Heil Co., 3000 W. Montana St., Milwaukee, Wisc.
Gerhauser, Henry (B), The Heil Co., 3000 W. Montana St., Milwaukee, Wisc.
Gruber, Earl (C), The Heil Co., 3000 W. Montana St., Milwaukee, Wisc.
Meyer, Arnold (B), The Heil Co., 3000 W. Montana St., Milwaukee, Wisc.
Stachowski, Al (B), The Heil Co., 3000 W. Montana St., Milwaukee, Wisc.
Storatz, Gottfried (B), The Heil Co., 3000 W. Montana St., Milwaukee, Wisc.

NEW YORK

Allen, G. M. (C), 30–44 Review Ave., Long Island City, N. Y.
Brown, Lowell H. (B), 5451 Palisade Ave., Riverdale, N. Y.
Butera, Salvatore (D), 609 Park Ave., Brooklyn, N. Y.
Carney, Edward (D), 67 Ranger Rd., Dumont, N. J.



DEFECTS

CUT TO LESS THAN 1%

Murex engineers don't claim to have X-ray eyes. They are generally able to help manufacturers solve perplexing welding problems because of their wide and varied experience in many industries with the welding of many products under all kinds of actual working conditions. Sometimes the suggestions made are based on many hours of consultation; frequently they are extremely simple.

Take, for instance, the case of the manufacturer of power boilers. In automatic welding, rejects were high and the chipping and rewelding excessive. The Murex representative made a few seemingly minor alterations in welding procedure, including changing the direction of the slot in the electrode coating to get better slag action.

The result? X-rays from then on showed defective portions to be less than 1%.

It is the obligation of the Metal & Thermit Corporation, through its engineering department, to help manufacturers engaged in war production speed up their welding —whether or not they are Murex users.

Write or phone our nearest office.

Specialists in welding for nearly 40 years. Manufacturers of Murex Electrodes for arc welding and of Thermit for repair and fabrication of heavy parts.

METAL & THERMIT CORPORATION
120 BROADWAY, NEW YORK, N.Y.
ALBANY · CHICAGO · PITTSBURGH
SO. SAN FRANCISCO · TORONTO

MUREX

ARC WELDING ELECTRODES

Corbett, William (D), 401—53rd St., West New York, N. J.
Dempsey, Bartholomew J. (D), 20 Hill St., Morristown, N. J.
Hay, Robert A. (D), 1778 E. 48th St., Brooklyn, N. Y.
Hechler, Charles, Jr. (C), Roslyn, Long Island, N. Y.
Nylon, Richard (D), R. F. D. 2, Bristol, Pa.
Partridge, Morris A. (B), 22-20 27th St., Astoria, L. I., N. Y.
Petrotta, Joseph (D), 1865 W. 12th St., Brooklyn, N. Y.
Watson, Charles H. (D), 1 Sherwood Terrace, Yonkers, N. Y.

NORTHERN NEW JERSEY

Bodine, Francis O. (C), 15 Abbington Terrace, Glen Rock, N. J.
Budnick, Michael D. (D), 620 Fulton St., Elizabeth, N. J.
Dobson, Thomas A. (C), Welding Training Inst., 23 Sussex Ave., Newark, N. J.
Dundas, Arthur S. (D), 228 Hudson St., Hoboken, N. J.
Dusche, John (C), 12 Elmwood Ave., W. Orange, N. J.
Grazeshi, Stanley (D), 422 St. Pauls Ave., Jersey City, N. J.
Jarman, William (D), 183 Watson Ave., E. Orange, N. J.
Kreidler, Carl E. (B), Cornell & Underhill, Inc., Hoboken, N. J.
Kutyla, John (D), 57 Laidlaw Ave., Jersey City, N. J.
Leith, Oliver M. (C), Wyckoff, N. J.
Mitchel, Charles W. (C), 246 Sinclair Pl., Westfield, N. J.
Muzzicato, Leonard (D), 360 Franklin Ave., Belleville, N. J.
Reusch, Lloyd E. (D), 14 Romaine Pl., Newark, N. J.
Rose, William (D), 188 Windsor St., Kearny, N. J.
Simms, Forde (C), 210 Franklin St., Bloomfield, N. J.
Suber, Ralph C. (D), 290 Verona Ave., Newark, N. J.

NORTHERN NEW YORK

Baker, Edwin O. (D), 205 Mohawk Ave., Scotia, N. Y.
Benedetto, Gerardo A. (D), 519 Liberty St., Schenectady, N. Y.
Bilonos, Mitchell P. (D), R. D. 2, Ballston Lake, N. Y.
Burtt, Arthur T. (D), 55 Union St., Amsterdam, N. Y.
Campbell, Raymond W. (D), % Army Inspector of Ordnance, U. S. War Dept., Schenectady, N. Y.
Cancro, Francis C. (D), 338 Milton Ave., Ballston Spa, N. Y.
Cerasaro, John (D), 364 Division St., Amsterdam, N. Y.
Charon, Fred A. (D), 25 Center St., Ballston Spa, N. Y.
Diel, Donald K. (D), 1357 Regent St., Schenectady, N. Y.
Esposito, Louis J. (D), 2040 Van Vrankon Ave., Schenectady, N. Y.
Fratianni, Frank J. (D), 336 Summit Ave., Schenectady, N. Y.
French, Willis J. (D), 205 Mohawk Ave., Scotia, N. Y.
Goggin, Dwight (D), R. D. 1, Stillwater, N. Y.
Hayes, Kenneth E. (D), 88 South St., Ballston Spa, N. Y.
Isolda, Fred (D), 16 Spring St., Gloversville, N. Y.
Jensen, Robert F. (D), 205 Mohawk Ave., Scotia, N. Y.
Kruse, Harvey H. (D), 312 Riverside Ave., Scotia, N. Y.
Lyons, Malcolm (D), R. D. 1, Watervliet, N. Y.
Marotto, Dominick (D), 847 Emmett St., Schenectady, N. Y.
Montagliano, Bennie C. (D), 858 Union St., Schenectady, N. Y.
Nienaltowski, Stephen F. (D), 111 Walnut St., Schenectady, N. Y.
Painter, J. H. (C), Welding Engrg. Sales Corp., 110 E. 42nd St., New York, N. Y.
Polcare, Joseph (D), 119 Clinton St., Schenectady, N. Y.
Schriner, Andy (D), 6 Packer Ave., Troy, N. Y.
Scranton, Edgar F. (D), 1 Railroad Ave., Watervliet, N. Y.
Snyder, Robert R. (D), 5 Congress Ave., Saratoga Springs, N. Y.
Valentine, Michael J. (D), 23 Christie St., Troy, N. Y.

NORTHWEST

Gipple, George (D), 1268 Marshall Ave., St. Paul, Minn.
Halonie, Victor S. (D), 844 E. 3rd St., St. Paul, Minn.
Jacobsen, Joe M. (D), 2901 Girard Ave. So., Minneapolis, Minn.
Olin, Clinton H. (D), 4220—31st Ave. So., Minneapolis, Minn.
Struck, Larr (D), 636 No. Victoria Ave., St. Paul, Minn.
Triden, Lewis W. (D), 4110 Xenia Ave., Robbinsdale, Minn.
Westmark, Donald H. (D), Route 2, Hopkins, Minn.

OMAHA

McGrath, G. E. (C), McGrath Welding Co., 4680 Leavenworth St., Omaha, Neb.

PEORIA

Smith, Albert (D), 710 Springfield Rd., E. Peoria, Ill.

PHILADELPHIA

Belcher, Floyd R. (C), 1018 So. 48th St., Philadelphia, Pa.
Davis, Charles H., Jr. (C), E. G. Budd Mfg. Co., 25th & Hunting Park Ave., Philadelphia, Pa.
Gordon, A. B. (C), The Linde Air Prods. Co., 1421 N. Broad St., Philadelphia, Pa.
Kreidler, Carl L. (C), Lehigh Structural Steel Co., Allentown, Pa.
Mogel, Howard W. (F), 39 So. Wyomissing Ave., Shillington, Pa.
O'Malley, Fred J. (C), 125 Fern St., Darby, Pa.
Schuster, William H. (C), 5814 Cedarhurst St., W. Philadelphia, Pa.
Sledesky, E. (C), Cramp Shipbldg. Co., Richmond & Norris St., Philadelphia, Pa.
Sowden, E. Kenneth (C), Malvern, Pa.

PITTSBURGH

Reisdorf, Russell C. (B), 173 Neville St., Emsworth, Pittsburgh, Pa.

PUGET SOUND

Foster, Bert (C), Weldit Tank & Steel Co., Bellingham, Wash.
Miles, Robert R. (D), Rt. 1, Box 974, Bremerton, Wash.
Parker, J. S. (C), American Bureau of Shipping, 1727 Exchange Bldg., Seattle, Wash.

ROCHESTER

Carter, Nelson B. (C), Eastman Kodak Co., Bldg. 23, Kodak Park Wks., Rochester, N. Y.
Farrell, John E. (D), 46 Perine St., Dansville, N. Y.
Nevin, William J. (C), West Main St., Avon, N. Y.
Slivka, John M. (D), 1236 Jay St., Rochester, N. Y.

ST. LOUIS

Westin, C. L. (B), Westinghouse E. & M. Co., 717 So. 12th St., St. Louis, Mo.

SAN FRANCISCO

Fambrini, Harry Guido (C), 28 Channing Rd., Burlingame, Calif.
Kremer, Eugene C. (B), 1704 Jenevein Ave., San Bruno, Calif.
Olds, Edwin W. (B), 1331—61st Ave., Oakland, Calif.
Rosenaur, Louis F. (C), 859—46th Ave., San Francisco, Calif.
Scionti, Anthony (D), 544 N. 17th St., San Jose, Calif.

TULSA

Snell, Fred (D), Reda Pump Co., Bartlesville, Okla.
Wolman, E. J. (D), % City Service, Box 1300, Ponca City, Okla.

WESTERN NEW YORK

Eberl, Leo (B), Eberl Iron Wks., Inc., 128 Sycamore St., Buffalo, N. Y.
Hoad, Francis W. (D), 48 East End Ave., Buffalo, N. Y.
La Judice, Sanford (D), 461 Forge Ave., Buffalo, N. Y.
Valentine, Ken E. (D), 103 Earl Pl., Buffalo, N. Y.

YORK—CENTRAL PENNA.

Abel, Charles (C), Dellinger Mfg. Co., Lancaster, Pa.
Barr, Robert (D), Box 115, Downington, Pa.
Bolen, Clyde (D), 933 E. Hay St., York Pa.
Bontreger, John (C), New Holland Mach. Co., New Holland, Pa.
Brackbill, Elias (D), R. D. 1, Gap, Pa.
Hohmann, Don N. (D), 1110 S. Pine St., York, Pa.
Maclay, Robert S. (D), Dept. of Public Instruction, Kiwanis Park, Lancaster, Pa.
Thoms, Joseph (C), 226 No. Ann St., Lancaster, Pa.
Wedmore, Dan (D), 112 E. Lancaster Ave., Downington, Pa.
Whartenby, Harry A. (C), 5357 Wingohocking Terrace, Philadelphia, Pa.

NOT IN SECTIONS

Harmon, Carl F. (D), 40 Grand St., So. Portland, Maine.
McLellan, David S. (D), 29 No. Van Buren St., Wilmington, N. C
Mehalov, John (D), United Weld Co., United, Pa.
Neidick, Albert (D), General Delivery, No. Windham, Maine.

SECTION ACTIVITIES

CHICAGO

The January 16th meeting of the Chicago Section was addressed by Mr. Ernest Kuehn, Factory Manager, Electro-Motive Corp., La Grange, Ill., who spoke on the subject "Welding of Diesel-Electric Locomotives and Internal Combustion Engines." It was brought out that welding has played one of the most important parts in the construction of the sleek streamlined trains. The locomotives built by the Electro-Motive Corp. are practically all welded. Even the modern Diesel engines that drive the locomotives are of welded design. A sound movie entitled "Diesel on the Railroad" was shown at the start of the meeting.

CLEVELAND

The January 14th meeting of the Cleveland Section featured an address by Mr. Ira T. Hook, Research Engineer for the American Brass Co. Mr. Hook spoke on the subject, "The Welding of Copper and Brass." Among other things, Mr. Hook said that the welding metallurgy of the copper alloys appears complicated by reasons of the large number of commercial metals in this group. He added, however, that fundamental responses of the individual constituents help to simplify the problem. His lecture also dealt with the reactions of the solid and molten copper alloys under welding heat of the gas and arc methods, the results to be expected and the practical applications.

The "Coffee Talk" was given by Mr. Louis B. Seltzer, editor of the Cleveland Press for the past 15 years. Seltzer, an animated and interesting speaker, refused to be confined in his subject matter and talked on "Today's World." He analyzed the latest events both in and behind the news.

COLUMBUS

The January meeting of the Columbus Section was held on the 9th at the Fort Hayes Hotel. A dinner meeting preceded the technical meeting. Mr. A. M. Candy of the National Cylinder Gas Co., presented a discussion on "Welding in Industry."

March 13th—Meeting—Battelle Memorial Institute. Moving Pictures (Materials), General Motors Corporation.

April 10th—Dinner Meeting—Hotel Fort Hayes, "Preheating—Welding—Normalizing," by C. J. Holslag, Electric Arc, Inc.

May 8th—Meeting—Battelle Memorial Institute. To be announced later—Col. G. F. Jenks, President, AMERICAN WELDING SOCIETY.

DETROIT

Mr. T. R. Lichtenwalter, Metallurgical Engineer, Republic Steel Corp., was the speaker at the January 9th meeting of the Detroit Section. Mr. Lichtenwalter spoke on the subject "Welding of Stainless Steels." Welding of stainless steels presents metallurgical characteristics distinctively peculiar and different from conventional carbon steel products. Mr. Lichtenwalter showed his picture "Enduro" and answered questions indicated by the film.

March 2nd—"Control in Spotwelding of Aluminum" by Paul H. Merriman, Glenn Martin Co., Baltimore, Md. This will be a joint meeting with the Society of Automotive Engineers. Mr. Merriman's paper, given at the Twenty-second Annual National Convention, A. W. S., was one of the outstanding presentations of the sessions. He discusses the over-all control, design, inspection, as well as production of this most timely subject matter. Because of the anticipated numbers attending, it will be a closed meeting. Plan now to ask for invitations for your guests; we can and will entertain a limited number. *Note:* This will be a Monday Evening Meeting.

April 3rd—"Stored Energy Welding" by Mr. Maurice Sciaky, Sciaky Bros., Chicago, Ill. Mr. Sciaky will be assisted by C. W. Dodge, Chief Engineer. The development of stored energy welding is one of the revolutionary processes in aluminum fabrication. Mr. Sciaky's organization is one of the pioneers in this type of welding and his presentation will not only be interesting from the historical viewpoint, but also from the accomplishment viewpoint.

May 1st—"Past Chairmen's Night, Ladies' Night, House of Magic." Following the successful experience of last year, we will again honor those chairmen who have been responsible for the continuty of our activities. There will be no speeches as such, but there will be entertainment in the form of "House of Magic" and dancing which will prove of interest not only to our members, but also to our wives and sweethearts.

INDIANA

The Indiana Section had a very interesting November meeting held in the plant of VAK Engineering Co. About two hundred members and guests attended. Mr. Malcom Judkins of the Firth Sterling Steel Co. of McKeesport, Pa., spoke on the subject of tool tipping with tungsten carbides. A movie showing the manufacturing of tungsten carbides was also shown.

Mr. Wm. B. Browning of The Linde Air Products Co. addressed the January 23rd meeting on the subject "The Importance of the Oxy-Acetylene Process in National Defense."

MARYLAND

The following is the program for the remainder of the season for the Maryland Section.

February 20, 1942—Subject: "Hard Facing Welding Alloys." Speaker: J. C. Blake, Lt. Commdr. U. S. N. R.

March 20, 1942—Subject: "Welding of Copper and Copper Base Alloys." Speaker: J. R. Hunter, Revere Copper & Brass Co.

April 17, 1942—Subject: "Electric Resistance Welding." Speaker: J. R. Merriman, Glenn L. Martin Co.

May 15, 1942—Annual Banquet and demonstrations.

NEW YORK

Mr. F. G. Flocke of the International Nickel Co. is scheduled to speak at the February 11th meeting of the New York Section. Mr. Flocke will talk on the general subject of fabrication of Monel, Nickel and Inconel. Then, Dr. W. G. Theisinger of Lukens Steel Company will provide a motion picture, with running comments, of the world's largest plate mill.

The fifth lecture in the series of Lectures being given by the New York Section under the auspices of Polytechnic Institute of Brooklyn, at that Institute, will be given on February 17th. Mr. G. S. Mikhalapov of the Taylor-Winfield Corporation will lecture on the subject of Austenitic Steels.

The New York Section held a joint technical meeting with the Society of Naval Architects and Marine Engineers at the Engineering Societies Building on January 13, 1942. Chairman for the evening was David Arnott, Vice-President and Chief Surveyor, American Bureau of Shipping.

The speaker of the evening was Mr. Harry W. Pierce, Supervisor of Welding, New York Shipbuilding Corporation, Camden, N. J., who chose as his subject "Distortion and Stress Problems in Shipbuilding." Illustrating his highly informative talk with lantern slides and blackboard sketches and diagrams, Mr. Pierce discussed the general problem of shrinkage and distortion in large structures, particularly large weldments and hulls of ships; the classification of preventative and corrective methods and their application to typical ship structures; and the relation of shrinkage and distortion to residual stresses as well as some consideration of residual or locked-up stress in marine work. Mr. Pierce proved not only an expert who knew his subject, but also one who could get it across in a simple and interesting manner.

As usual, the regular "get-together" dinner of the New York Section was held at Old Timer's Grill. Then, during the

half-hour period preceding the technical meeting, a "Welding and Cutting Question Box" session was held under the chairmanship of Mr. H. R. Morrison, Union Carbide Co., New York. This period designed especially for welding operators and others engaged directly in welding work was highly successful. Questions were submitted either from the floor or were written on a special form accompanying the January meeting notices. After a question had been read, it would be answered by a member of a panel of experts.

The first of the series of lectures of the New York Section in cooperation with Brooklyn Polytechnic Institute got off to a flying start on January 6, 1942. The attendance of more than 150 was not only a tribute to the efforts of the Lecture Course Committee, but also was a definite indication of the interest of those engaged in welding in the type of material covered. The lectures, which are held on Tuesday evenings and will continue throughout the winter until April 7th, are being presented by the authors who have contributed to the preparation of chapters in the forthcoming *Welding Handbook*.

NORTHERN NEW JERSEY

The regular monthly meeting of this Section was held on January 20th at the Essex House, Newark, N. J. Dinner at 6:30 P.M. in the Starlight Terrace preceded the meeting. Mr. David Arnott, Vice-President of the American Bureau of shipping spoke on the subject "Welding in Shipbuilding." Mr. Arnott's lecture was illustrated by lantern slides of typical welded ship structures. These were used to explain the economies of time and material that are being accomplished by welding in the shipyards.

Mr. I. B. Deck, of The Linde Air Products Company spoke on Flame Priming as an introduction to a moving picture film on The Grand Coulee Dam which was shown after his talk. The fundamentals of flame priming were explained and further examples were cited of its current applications, including shipbuilding. Close-up views of the film showed the part played by flame priming during the construction of the dam.

NORTHWEST

Mr. R. W. Sternke, Superintendent and Production Manager of Lakeside Bridge & Steel Co., spoke on "Jigs and Fixtures" at the January 15th meeting of the Northwest Section. Besides illustrating his talk by a number of slides, Mr. Sternke showed colored movies portraying the application of jigs and fixtures, and also various plant operations.

March 19th—"Welded Steel Structures," by LaMotte Grover, Air Reduction Sales Co.

April 9th—"Metallurgy of Welding," by E. C. Chapman, Combustion Eng. Co.

May 14th—Annual Meeting.

OKLAHOMA CITY

The Oklahoma City Section met at the Biltmore Hotel January 8th. Through the courtesy of the United States Steel Corporation a sound picture entitled "Steel—Man's Servant" was shown. This picture was in technicolor. The principle address of the evening was presented by Mr. Frederick H. Dill, Welding Engineer with the American Bridge Company. Mr. Dill's subject was "Structural Welding Under Current Codes and Specifications." This topic was particularly interesting, especially at this time.

The College of Engineering at the University of Oklahoma, Norman, is completing the installation of a new sub-panel on its welding laboratory. This will permit the installation of two more welding stations, in addition to the six already available, and will also provide suitable capacity to operate the laboratory's electrically heated heat-treating furnaces.

Twenty-eight men are enrolled in the Welders Training Course at the University and an average of four men each week are completing training as shipyard welders.

March 5th—Still open. Dinner Meeting, Biltmore Hotel, 6:30 P.M.

April 9th—C. I. Lundgren, the Wichita Representative of the Taylor-Winfield Corporation of Warren, Ohio, who will speak on "Resistance Welding."

May 7th—Arthur N. Kugler, Mechanical Engineer, Applied Engineering Department, Air Reduction Sales Company, New York City, N. Y. Subject: "Designs of Jigs and Fixtures for Welding." Dinner Meeting, Biltmore Hotel, 6:30 P.M.

June 4th—Annual meeting, installation of officers and Dutch Lunch.

PHILADELPHIA

Normally, no meeting is held in December. This year a meeting was tried and met with marked success. Approximately 100 members and guests attended. A very excellent talk was given by Mr. R. T. Gillette of the General Electric Company. His subject was "Resistance Welding."

Through the Defense Committee of The Engineers' Club, the Section has been asked to cooperate in every way possible with the coordinator of civilian defense for the Philadelphia area. Mr. Wm. S. Wagner will represent the SOCIETY on this committee and it is hoped that all who are asked to help him will cooperate to the fullest extent.

March 16th—"More Important Fields for Gas Welding," by A. N. Kugler, Air Reduction Sales Co.

April 20th—"Structural Welding," by H. W. Lawson and W. F. Carson.

May 18th—"The Welding of High Pressure Piping." Speaker to be announced.

ROCHESTER

"Fabrication of Monel, Nickel and Inconel, Solid Plate and Clad Plate Construction" was the subject of the talk by Mr. F. G. Flocke of the Development and Research Division of The International Nickel Company, at the January 8th meeting of the Rochester Section. In his talk Mr. Flocke covered the following: general properties of these materials; forming and shaping; the joining of these materials by silver brazing, soft soldering and welding; forming and welding in clad plate construction. Mr. Flocke also presented a film "Nickel High-Lights" which depicts the mining, milling, smelting and refining of nickel.

ST. LOUIS

Mr. A. J. Moses, General Manager, Hedges-Walsh-Weidner Division of Combustion Engineering Co., addressed the January 9th meeting of the St. Louis Section on the "Progress and Improvement in the Radiographic Examination of Welded Joints." Mr. Moses told of the startling improvements that the new 1,000,000-v. X-ray made possible in the radiographing of very thick weld seams.

March 13th—"Welded Steel Structures," by LaMotte Grover, Air Reduction Sales Co.

April 10th—"Machine Design," by John D. Gordon, Taylor-Winfield Corp.

May 8th—"Crater Cracks and Fish Eyes, Their Cause and Cure," by C. J. Holslag, Electric Arc Welding Co.

SOUTH TEXAS

Mr. J. M. Hughen, President of Pennsylvania Shipyards, Inc., Beaumont, Tex., has been elected Chairman of the South Texas Section for the fiscal year, with Mr. W. T. Hudson of Chicago Bridge and Iron Company, Vice-Chairman. The election of these officers was announced at a dinner meeting at the Houston Country Club on January 5th, and the re-election of Mr. W. H. Greer as Secretary was also announced. Six members of the Executive Committee elected to serve for a two-year term are G. W. Woods, L. H. Courtright, E. C. Jackson, M. P. Hare, R. C. Bender and T. D. Ketchbaw.

Past-Chairman pins were presented to all members having served the South Texas Section in the capacity of Chairman, and the four such officers are Marvin Cook, L. H. Courtright, B. W. Farquhar and G. W. Woods.

Through the courtesy of the American Airlines, Inc., a sound motion picture "Flagships of the Air" was shown.

BOUND VOLUMES
1941

A FEW COPIES LEFT

Bound in attractive imitation black leather covers.

PRICE

$6.50 to non-members

$5.00 plus postage to members